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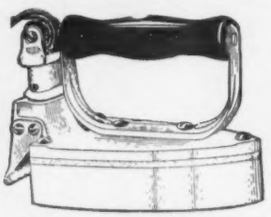

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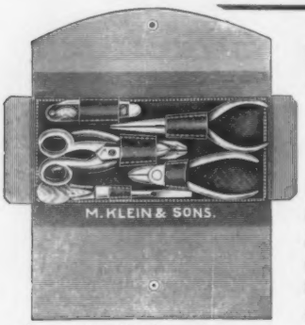

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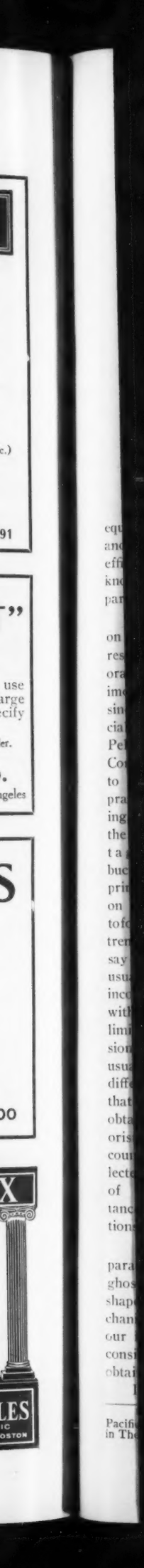

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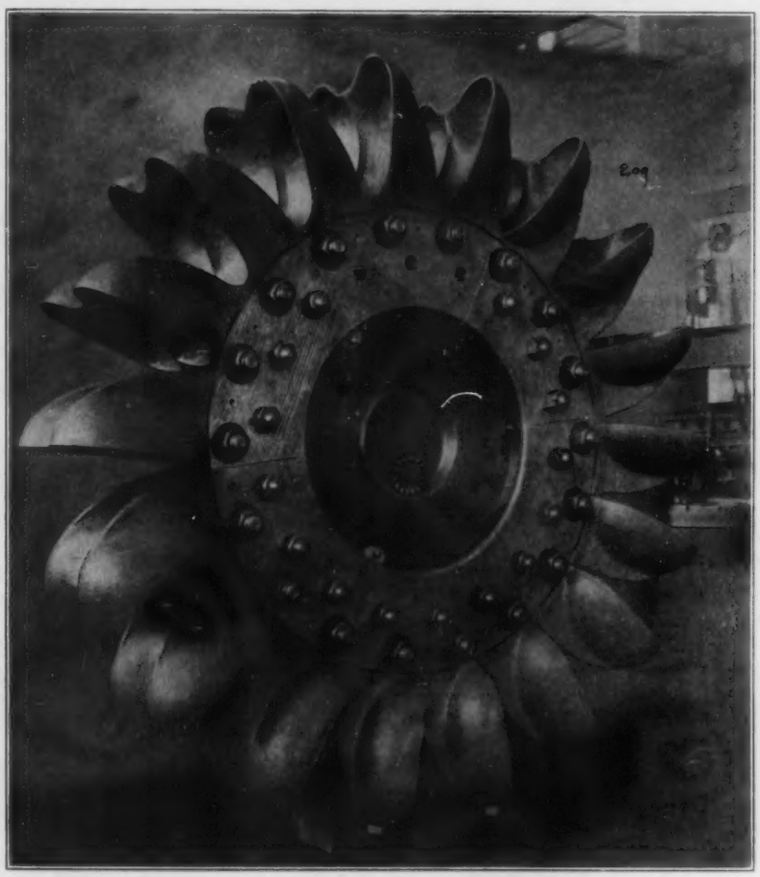
TANGENTIAL WATER WHEEL EFFICIENCIES.[1]

BY GEORGE J. HENRY, JR.

It is not the writer's intention to attempt to determine the equation for the so-called true hydraulic curve, or to exhibit new and improved bucket shapes which will greatly increase the efficiency of a water wheel, but rather to discuss some of the well-known shapes of buckets and particularly the ellipsoidal as compared with the general form of the Pelton bucket.

The conclusions arrived at are not theories deduced entirely on paper, but are the result of a very elaborate series of experiments carried out since 1899 in the special laboratory of the Pelton Water Wheel Company with a view to scientifically and practically determining, beyond a doubt, the relative advantage of different bucket shapes. The printed information on this subject heretofore has been extremely misleading, to say the least, and usually the result of incomplete theorizing within very narrow limits. The conclusions arrived at have usually been entirely different from those that would have been obtained had the theorist taken into account, instead of neglected, certain factors of extreme importance to the deductions.



5000 K. W. Pelton Wheel for Electra Plant, Pacific Gas and Electric Corporation, to Operate Under 1400 ft. head at 1400 r. p. m.

We will not again parade that elusive ghost—"a new bucket shape"—that is conjured up by every suburbanite with a "mechanical turn of mind" who has wielded a garden hose. It is our intention, however, to present a few facts for your worthy consideration, and particularly to those of you interested in obtaining the best results from water wheel plants.

During the writer's experience in the design, construction and operation of tangential water wheels for the past twelve years, new types of tangential water wheel buckets have been brought out with startling rapidity; every rain seems to bring out a new crop—like mushrooms. Most of them do not last any longer than mushrooms. Some few, due to liberal advertising, are forced before the public, but usually die a natural death after a short time, as much because of poor engineering or financial disability, as weakness in bucket design. The average inventor fails to consider the work of those who have gone before, and suffers from the belief that if the patent office will grant a patent there must be superior results obtainable. Or, rather than giving actual results, such as Prony brake measurements on carefully designed wheels for comparison, he will state that it will "reverse a Pelton" when put on the same shaft, etc., all of which means nothing as far as relative efficiency goes.

Another frequent fallacy is that to get maximum efficiency it is only necessary to provide a bucket which will receive one blow at each revolution, usually at the instant of entering the stream.

To obtain the best efficiencies it is necessary to have the proper pipe line, gate valves, nozzles, water wheels and buckets, wheel case, wheel pit and tail-race, and all of these parts must be properly designed for the particular conditions under which they are to operate, and all will vary with the head or pressure—the water quantity and the revolutions which the wheel is to make. Many a water wheel bucket has been overworked for years, and then charged up with losses that occur because of its being improperly worn, due to this overwork. Again, buckets

[1]Reprint, by request, of paper read at Seventh Annual Convention of the Pacific Coast Electric Transmission Association, June 16, 17, 1903, and published in The Journal of Electricity, Power and Gas, of September, 1903.

are frequently charged up with all kinds of losses which are really due to something for which the bucket is not responsible. Pressure or wheel diameter, or speed on a given wheel, cannot be varied radically without materially altering the efficiency. Many hydraulic plants are in operation and developing not over 65 per cent. between the flume and water wheel shaft where the *bucket* itself is capable of developing 90 per cent., and where a very inexpensive change could be made which would increase the gross efficiency very materially and cause a great saving in the water bills.

On the other hand, there are probably more errors made in buckets than in any other one element of a tangential water wheel plant. The writer knows of but one inventor, Mr. L. A. Pelton, who has based all of his work on tangential wheels on actual practical results obtained through laborious experimental work. All other shapes, as far as we know, are the result of a happy, or, usually, an unhappy thought, and it is curious to note how at variance are the shapes and arguments put forth to support each type as it is introduced.

The Cazin bucket is built up on the entering lip and cut away on the sides, which are made rectangular, and Mr. Cazin issued quite a mathematical treatise, in the form of a trade catalogue, to prove the value of his type of bucket.

The ellipsoidal type of bucket is cut out in front like the Dodd, and is supposed to contain smooth interior cavity surfaces, whereas the De Reamer has a number of interior ridges or walls to guide the water in fixed lines along the surface of the bucket cavities. In the ellipsoidal, before mentioned, great stress is laid on the smooth interior surfaces, from which 1 or 2 per cent. is supposedly gained, and then the front is largely cut away, resulting in a loss usually much more than is gained by the smooth surface.

Some inventors insist that buckets should discharge from the top or edge nearest the wheel center, such as the Risdon and Hug. Others, again, that the discharge should be from the front and side furthest from the center, and still others, that this discharge should be from the sides, as in the Cazin, Berry Blue and Pelton. This latter class is by far the more numerous.

In actual practice, each bucket, of course, discharges to some extent on all three sides of the cavity, but the maximum discharge may be distorted to any particular point by changing the interior surface of the bucket cavity. Some inventors insist on periphery. In fact, the whole question of bucket design seems to be largely a matter of guess work, usually based on assumptions entirely at variance with facts, and therefore leading to wrong conclusions.

An inspection of the stream diagrams, made from actual experiments, will make this question of stream path over the surface of the different bucket shapes better understood. It should be borne in mind that the bucket is doing work throughout its entire path, within the stream lines, and we therefore give the lines taken by the water in three different positions of the bucket First, at the moment of entering; second, at the point of developing maximum power; and third, in its final position before leaving the stream. In these diagrams the same relative bucket and wheel and stream dimensions are maintained for each form, so that comparisons may be more readily made.

With these diagrams before us, let us bear in mind that to obtain the best possible bucket efficiency it is necessary that the water jet be taken up on the bucket surface and brought to as near rest as possible with the least loss of energy. This loss will then be made up of:

1. The discharge velocity with which the water leaves the bucket with respect to a point fixed in space. Note that this velocity will vary with every position of the discharge as bucket moves.
2. Air and surface friction inside the bucket.
3. Imprisoned water in the bucket.
4. Variation in the stream form, producing erratic conditions of impact and flow on the bucket surface.
5. That occasioned by the stream being displaced by the entering bucket.
6. Eddy currents in the buckets.
7. Water which does not give up all its energy to the bucket (a special case of the first condition mentioned above).

The following methods of correcting these losses suggest themselves:

1. If the water moves in a curved path on the bucket surface, being taken up on a surface as nearly tangent to the entering jet as possible, and is turned through a curve of as nearly 180 degrees as possible, still allowing the discharge to clear the back of the next bucket, and the discharge is at the same distance from the wheel center at all times, the first loss will be kept down to a minimum.

2. If the water moves in a smooth curved path at all times, as shown in the Pelton bucket diagram (Photo A) and the stream form is retained, spreading out gradually and encountering no sharp corners or angles, and the discharge is thin and fan-like on the sides, and the least number of buckets used, then the air and surface friction will be a minimum.

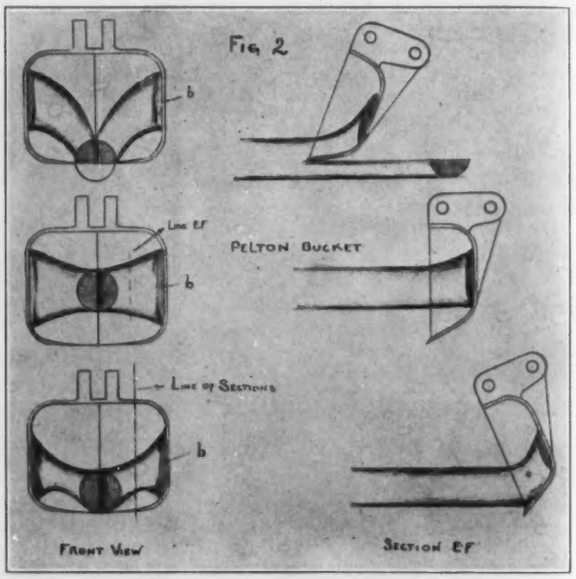


Photo A. Diagram of Discharge From Pelton Bucket. Note Thin Fan-Like Discharge at B.

3. The imprisoned water will cause very little loss if the bucket surfaces are smooth and so shaped on the back and front that the water, after expending its energy, will freely leave the wheel.

4. Variations in stream form producing erratic conditions of impact and flow will be avoided by carefully following the angle of the front and the curvature of the cavity surfaces.

5. The shape of the cutting edge and the dividing knife, and their relative angles to the stream, are the principal causes of the loss occasioned by the displaced stream.

There are still other losses which should form an important consideration in wheel design, but which are not directly affected by the bucket shapes. These are:

8. Journal friction.
9. Windage due to the wheel acting as a centrifugal blower.
10. The losses in the nozzles, gate valves and pipe lines.

Every water wheel plant has all of these losses to a greater or less extent, and it is obvious that when 80 per cent. is then obtained from an operating wheel, the improvement of any one of these, or, for that matter, the entire elimination of any single loss, if this were possible, would not, to any great extent, improve any wheel's gross efficiency. The writer has a number of times obtained as high as 90 per cent. efficiency in laboratory test on buckets only.

Let us give some attention to the above detailed losses, and endeavor, as far as possible, to determine those points, the careful calculation of which will obtain for us the best possible tangential water wheel bucket.

1. Given a certain stream of water at a given spouting velocity, it is advisable that this be taken upon the bucket surfaces of just enough buckets to catch every particle of water on the dividing wedges and turn it all on the curved surfaces, and discharge it at just enough velocity (and entirely in a direction at right angles to the entering stream axis) to clear the next following bucket. This resulting velocity will be the tangent of the discharge angle, multiplied by bucket velocity.

2. The air and surface friction must be maintained as small as possible by the use of a nozzle which will give a perfectly circular and solid stream. The bucket surface and cutting edges must be of a shape which, with a minimum wetted surface, will allow the stream, without crowding at any point, to spread out in a thin fan-like discharge on each side. The surface must be such that the water will not adhere, and as smooth as possible.

The surface may be ground and polished, or better, ground and well painted with a special compound. If all of these points are carefully studied out and the front of the bucket properly shaped and not cut away too low, the imprisoned water will not cause any appreciable loss.

The windage will also be a minimum if the number and surface of the buckets is a minimum.

The above losses and considerations for their prevention are all of such a nature, and so entirely interdependent, that their quantitative value cannot be predetermined except in a general way. In designing a water wheel, however, it is certain that the exercise of the most careful judgment is necessary in the laying out of the surfaces, so that all the losses, or at least their sum, or total bucket loss, will be kept down. Thus, if too much bucket surface be allowed, we increase both surface friction and windage for a given output, and if we attempt to cut these down by reducing the surface, we crowd the stream,

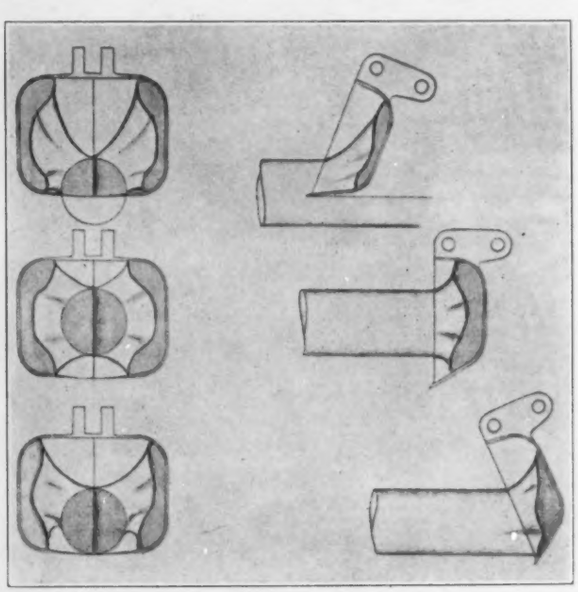


Photo B. Diagram Showing the Effect of Overcrowding a Water Wheel Bucket Resulting in Uneven Mechanical Erosion Cutting Out the Corners Rapidly.

so that eddy currents will occur and the stream will not properly discharge from the bucket side, as shown in Photo B.

It will now be seen that it is absolutely impossible to get equally as good results from a certain shape of bucket, under all conditions of wheel and stream diameter and water pressure, but that to get the best efficiency, a bucket must be designed for each set of conditions.

When an investigator says, "Suppose no frictional resistances exist in the bucket, and let the stream be prevented from spreading laterally—also neglect losses due to impacts, loss of head in the nozzle, journal friction and resistance of the air"—however interesting a conclusion he may come to mathematically, the result to the purchaser or the builder is not only entirely useless, but frequently misleading to a dangerous degree.

By carelessly omitting some of the above considerations, many makers who have obtained very good results on some one wheel, fail to secure even a reasonable efficiency from others,

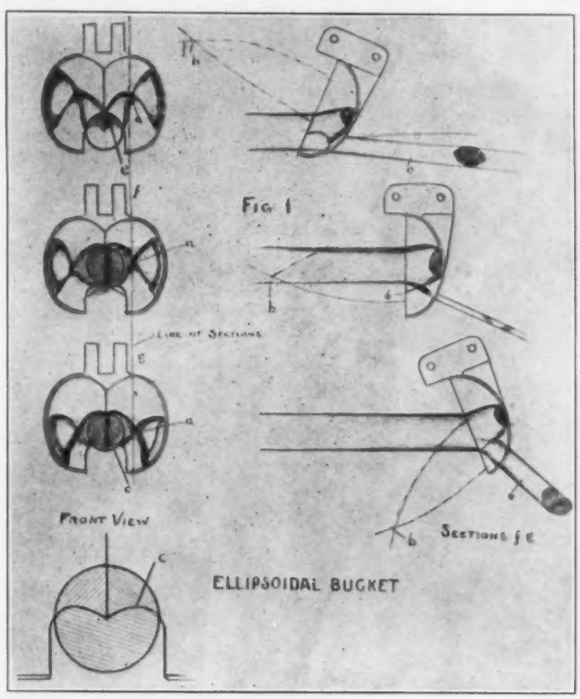


Photo C. Diagram Showing Path of Water in an Ellipsoidal Bucket in its Different Positions. Note Point of Disturbance at A, Flat Impact and Division in Two Planes at C, Nodes of Discharge B. Leakage of Pressure Water E.

built on similar lines, but for working under different conditions.

The writer believes that there is no such thing as a bucket shape, which, by simply enlarging or reducing, may be adapted to any set of conditions.

Some of the familiar bucket types are grossly deficient in the most elementary requirements for efficiency and best practical results.

All bucket shapes may be divided into two classes, in the first of which we have a variation in the shape of the cups on each side of the dividing wedge, and the second in which we vary the front wall or entering lip. Let us give some attention to these two points.

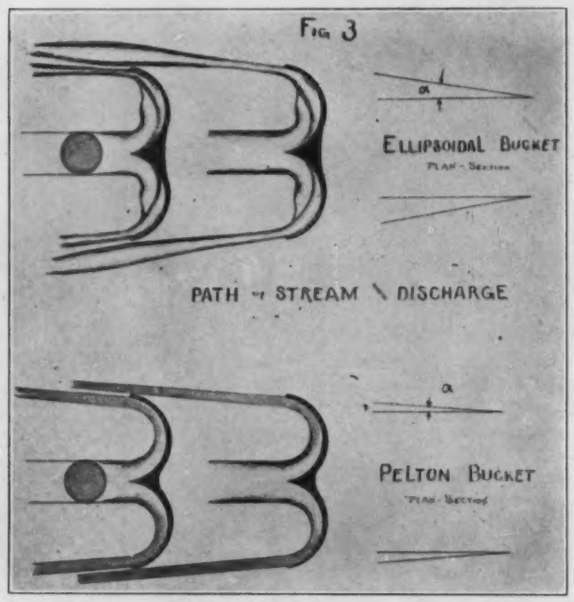
In the first place, no stream of water can divide on the central wedge and gradually spread out, if the surface of the bucket is concave with a deepest point (See Photo C), as there will be a tendency for all the lines of flow to cross on this point *a*, and then spread out again after passing over it. This crossing or "impact accumulation" and the consequent eddy currents at the deepest point cause more rapid wear here than elsewhere, as also a considerable reduction in efficiency. The water again spreads out, after crossing the deepest point, but before leaving the side of the bucket the curvature of the walls tends to produce a second node, as shown at *b*. It is the writer's belief that there should be no single deepest point in a water wheel bucket, but rather that the flowing stream, after impact on the dividing wedge, should follow, practically, a cylindrical surface, so that the stream may spread out in a fan-like shape at discharge, as shown in Photo A.

In reference to the front of the bucket, this should be neither too high nor too low. If the front be too high, as in the Cazin,

then it must be set at such an angle of entry to avoid disturbing the stream, that there will be eddy currents set up; if too low, all the water will not be caught without a great increase in bucket surface. Under no circumstances should the entire front be left out, as in the Berry and Doble as used at Blue Lakes.

Some wheel builders state that if the bucket has any front in line with the stream, this "slaps" or "pushes" a portion of the stream out of the way and accordingly reduces the efficiency by this amount of lost stream. This is not the case by any means, as far as the design of Pelton bucket is concerned, but on the contrary, the stream enters perfectly and entirely without disturbance. In a bucket with a front wall and properly designed throughout, the solidity of the stream is not interfered with, even to the slightest extent, until impact commences on the central interior dividing knife. All buckets which show wear and have been properly set and operated confirm this, as no wear occurs on the exterior of the front wall. The bucket here illustrated, although worn out on the inside, is clean on the front wall and back. See Photo D.

Another fallacy shared in by many engineers is the mis-statement that a bucket without a front wall cuts the stream in but one place. Nothing could be further from the truth. Every



Ce Plan View of Buckets Showing the Thin Discharge Occurring From the Pelton and Smooth Flow in the Cavities.

bucket with a dividing wedge, splits the stream in two places. One of these being the plane of rotation through the central wedge, and the other containing the boundary line of the bucket and parallel with the wheel axis, that is by the front of the bucket whether high or low. The stream is thus divided into three parts at the intersection of the two planes, as shown in Photo Cc and Photo E, illustrating the ellipsoidal bucket.

Any bucket having a central dividing wedge divides the stream into two planes, whether the bucket has a front wall or not. There are no exceptions to this rule, and by the very nature of things it is impossible for a bucket to enter the stream without cutting the stream with the front or bottom surface parallel with the shaft. This double plane division occurs in the buckets of the Pelton, Risdon, Dodd, Hug, DeReymer, Ellipsoidal and Berry, and the more nearly the stream (in both divisions) is taken up in the line of flow, the better the efficiency that will be obtained.

With buckets of the Berry and Ellipsoidal types, a large percentage of the water entering each bucket strikes a comparatively flat portion of the bucket. See Photo Cc. If we bear in mind that the efficiency of a flat surface running under the same conditions is theoretically only fifty per cent., and practically much less, than when received on the wedge, we readily see that this loss, due to part of the stream striking on a flat surface drags down the efficiency that would be obtained if the bucket were provided with a curved front surface or entering lip.

In regard to the division of the water jet in two planes: Consider for a moment any bucket in a position where the stream is partly entering it and the remaining portion of the stream passing on to the bucket next ahead; then that portion which enters the first bucket, has been divided by one plane, namely—that passing through the bucket front line—and again in the bucket division has occurred on the central wedge or it is clearly split into three parts by two planes. The accompanying Photo E is of an ellipsoidal bucket in which the patentee claims this does not occur and where the three sections by two planes are clearly shown. (See, also, Photo EE.)

We do not see how anything would be gained in the way of efficiency, if the division into three parts could be avoided, as has been erroneously claimed by the inventor of the ellipsoidal bucket. The entry of the bucket front line into the stream, if properly made, can be the cause of but an infinitesimal amount of power loss, if any, which we are by no means prepared to admit. In fact, a bucket, to give anywhere near a proper efficiency, in addition to the reason given above, must have a considerable front wall, otherwise, after impact has occurred on

Photo D. Pelton Bucket Showing Absence of Wear on the Back and Front Wall Although Bucket is Worn Through Due to Long Continued Use With Too Large a Stream.

the bucket surface, the jet will spread, and a large percentage of it find its way out, without having given up more than a small part of its velocity, and therefore its energy. This is not only so during entry, but during the entire passage of the water through the stream, and, as paradoxical as it may seem, it is a fact, that a greater disturbance in the stream, as far as those conditions which should be maintained for maximum efficiency are concerned, is caused by cutting down the height of the front wall below the splitting wedge than by leaving it well up. This is not a theory nor mathematical deduction, but a readily demonstrable fact which any interested parties may very easily prove.

There is another branch of this subject which is of considerable interest, and one, if carefully studied, that leads us to very important conclusions, viz., the erosion or bucket wear which occurs in every plant to a greater or less extent. As stated before, the course followed by a stream of water, after impact on a Pelton bucket, is such as to give a discharge almost entirely from the side of the bucket. This is shown diagramatically in Photo A, and also experimentally in Photos F and G.

In this latter photo we have a stationary Pelton bucket receiving the correct size stream and discharging it from the sides. The course taken by the discharge will be slightly different as

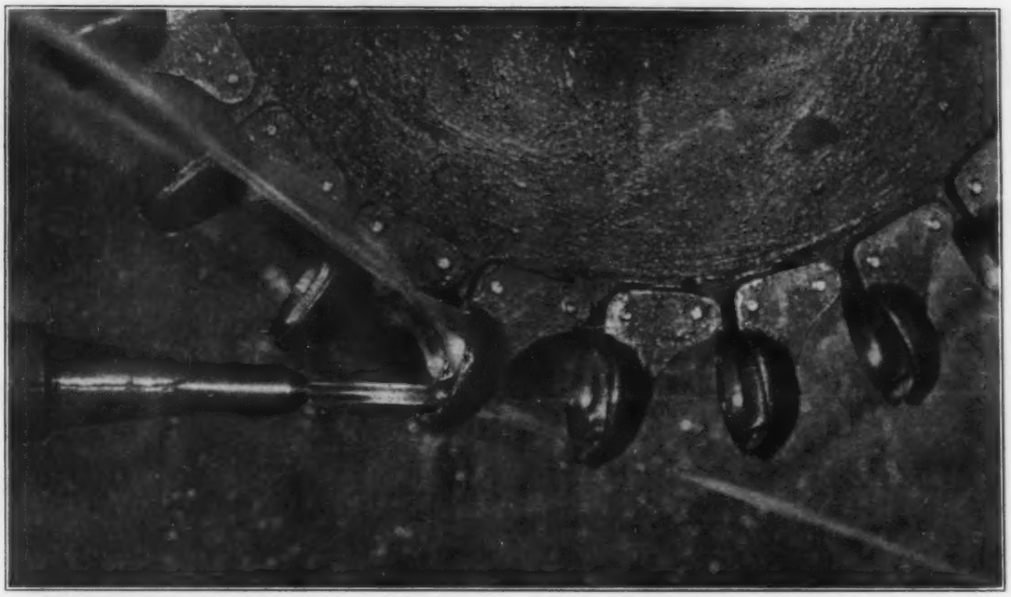


Photo E. Ellipsoidal Bucket Showing the Stream Division in Two Planes and the "Nodes" in the Discharge Water Like a String in Vibration Instead of a Thin Fan-Like Discharge. Compare Photos C, G. H. T.

the wheel rotates, but the discharge will always be parallel with the entering jet, as illustrated in Photo H. If these statements are correct, we would find in properly designed and installed Pelton plants, where all the adjustments and sizes of streams used were correct, that the buckets would wear evenly, at least for a considerable time, until the slight pits, which almost invariably occur, would start local action, resulting in considerable wear spreading around these pits.

It is a fact worthy of notice, although I think not mentioned in the discussion on "erosion" at last year's proceedings, that erosion met with in hydraulic practice is usually of two kinds. First, we have that due to the impact of cutting particles, which acts exactly as a sand blast—the sharp corners of the quartz sand particles cutting away the material of the bucket surface. A bucket eroded by this process is shown in Photo P. Secondly, we have a chemical erosion or corrosion, occasioned, I believe, by the escape of imprisoned air or air or other gas in solution, which released suddenly under high pressure may carry with it a certain amount of nascent oxygen, which on the clean metal surface would promote rapid oxidation. It usually starts at any imperceptible inequality in the castings, such as infinitesimal blow holes. The water moving over the surface and jumping across the blow hole crater releases the oxygen of the air, possibly more readily than the nitrogen. This gives us a small pocket, or blow hole, having clean surfaces from the water friction, filled largely with oxygen gas. The oxygen combines with the clean metal, forming an oxide coating, which is cleaned off by the water friction, which will invariably occur at the slightest change in position of bucket. The result is that the oxidizing process is repeated—the hole rapidly growing larger.

We would expect, if the above theory of chemical erosion is correct, to find the oxidized pits, as they become larger, increasing more rapidly in the direction of the bucket wedge, or creeping towards the direction from which the stream ap-

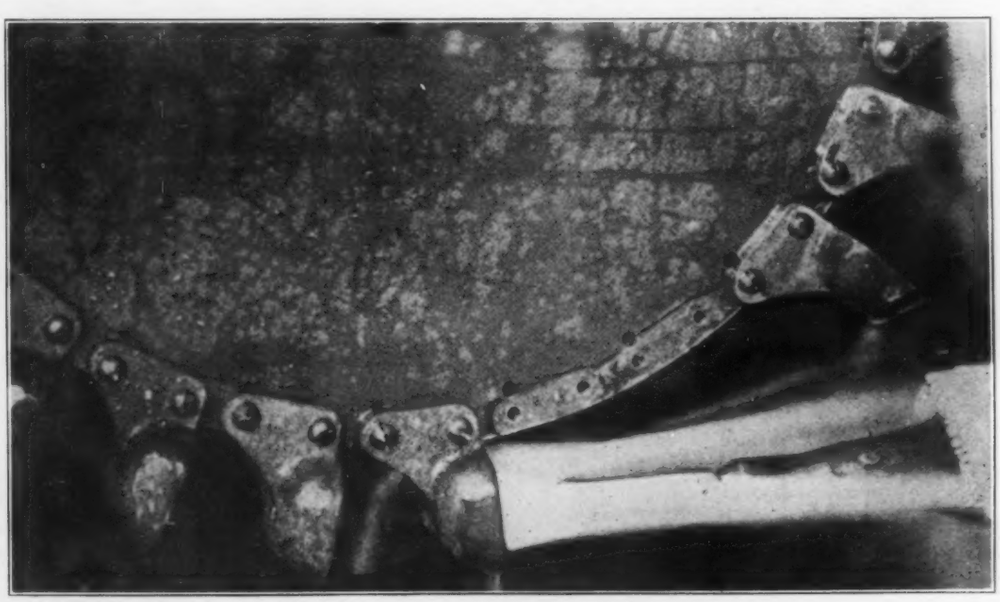


Photo G. Pelton Bucket Showing Parallel Discharge From Bucket Sides.

proaches, rather than from it, as the oxygen would naturally be released on the side of the pit from which the stream approaches. Such seems to be actually the fact where we can obtain an example of chemical erosion independent of mechanical erosion.

Photo J shows you a bucket taken from one of the wheels at the Santa Ana Station of The Edison Electric Company after

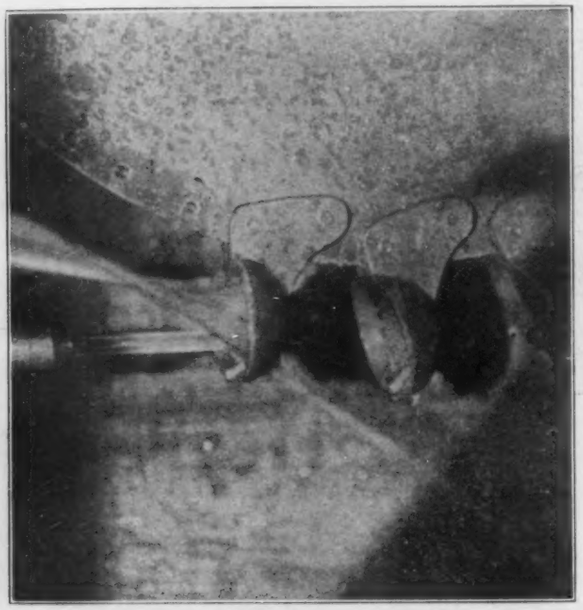


Photo EE. Ellipsoidal Bucket Showing the Twist in the Discharge and the Leakage of Pressure Water Through the Front Even Though Stream Has First Fully Entered the Bucket Cavities.

about twenty-seven months operation, during which it was driving a 750-kilowat generator from a single stream under about 700 feet head. Here you will find the oxidized pits above mentioned, which are of the color of gun metal—the oxidized

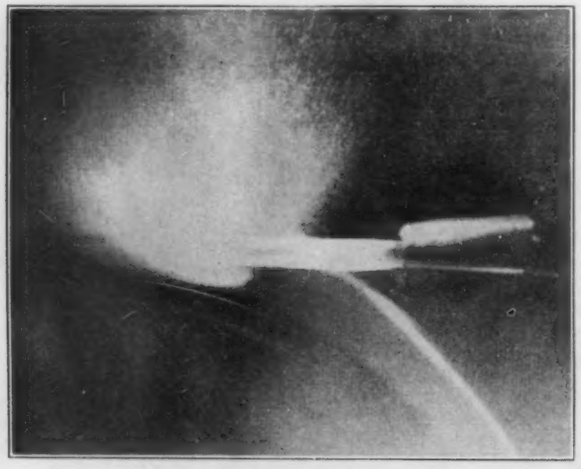


Photo F. Tangential Water Wheel Fitted With Pelton Buckets Showing the Discharge at Almost Zero Velocity (the Individual Slow Moving Drops of Discharging Water Are Observable) and That the Shape of the Jet Is Maintained Until Impact in the Center of the Bucket Where the Entire Energy Is Removed From the Water by the Bucket Resulting in Maximum Efficiency.

depressed surfaces being clearly outlined from the smooth steel surface over which the water flows. If the erosion of these pits were due to eddy currents, the oxidized surface would be removed by such erosion. Moreover, if mechanical erosion accounted for the pitted surface of most of our water wheels,

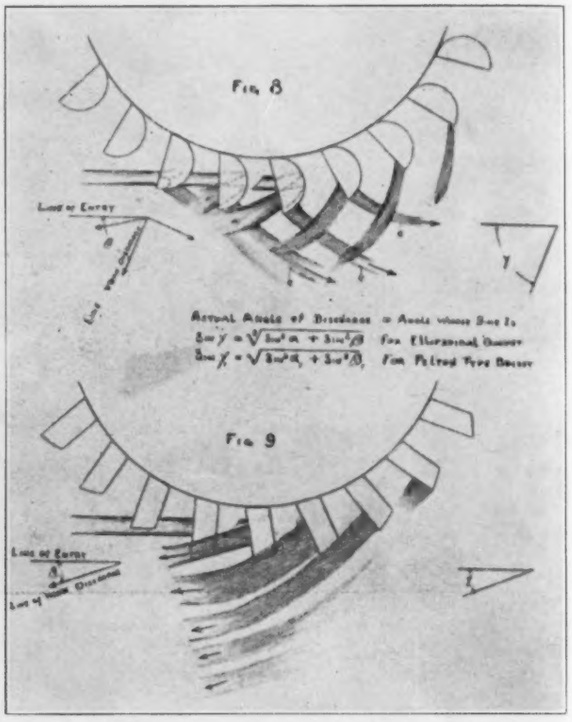


Photo H. Diagram Showing the Path of Discharge From the Ellipsoidal Bucket (Figure 8) and From the Pelton Bucket (Figure 9).

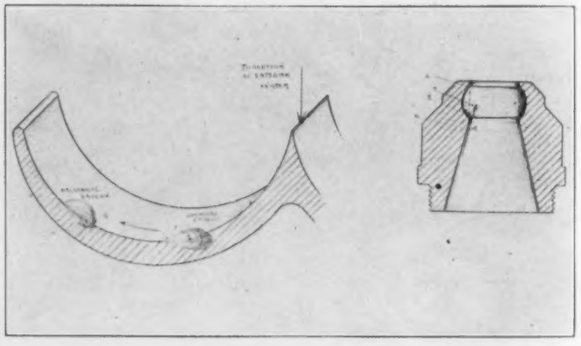


Photo I. Diagram of Chemical and Mechanical Erosion Originating at Points F and G Respectively and in the Nozzle Tip Which Is a Scale Drawing From a Tip Eroded in Actual Operation—Chemical Erosion Originating at A.

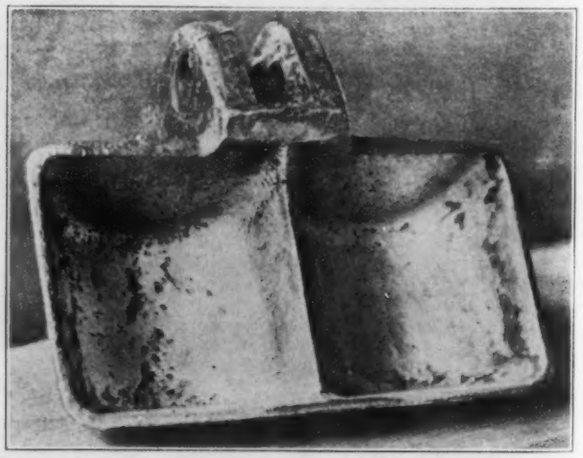


Photo J. Cast Steel Pelton Bucket From the Edison Electric Company's Santa Ana Station Showing the Even Wear When the Proper Size Stream Is Used; Showing Also the Chemical Erosion and Oxidized Pits in the Steel Surface. The Original Paint Is Still Observable on the Backs and Edges of the Bucket After Several Years' Use.

Photo K. A Bucket From One of the Early Blue Lakes Wheels Showing the Impact on the Flat Surface and the Chemical Erosion on the Inside.

we would find the dividing knife, or splitter, the most heavily worn part. This, however, is not the case in most instances, the pitting usually occurring in the bottom and sides of the cavities. It will be readily seen that, after these pits grow large enough to alter the course of the water, they will completely change the path of the jet in the bucket cavities, and we will then have all sorts and kinds of erratic shapes, which shapes are in no way governed by the original curves of the buckets. We thus find on the same wheel buckets worn through in entirely different spots, bearing absolutely no similarity to each other, although they all started out under exactly equal conditions.

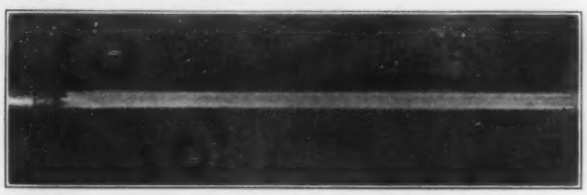


Photo L. A Water Jet From a Standard Pelton Tip.

The small bronze Doble bucket with the open front, originally used in the Blue Lakes plant, Photo K, clearly shows the beginning of this pitting process and also the direction of the water flow over the bucket surface. This direction of flow also shows the impact, on a comparatively flat surface, in open front buckets of this type, as mentioned before, unless built with a front wall.

In water jets carrying imprisoned air, or air or gas in solution, due to the high pressure, we would expect to find, on relieving this pressure, a gas discharge from the outside of the stream. Photo L shows you a stream under fifty-foot head, carrying air in solution. The stream at the instant of leaving the tip is perfectly clear; an instant later, or about two diameters from point of issue, we find a slight enlargement of the stream, which the writer believes to be due to the imprisoned gas freeing itself on the relief of pressure. This disengaging process continues in this instance for about fifteen stream diameters, after which the stream begins to again clear up, although at no point is its rigidity or shape interfered with.

Photo M shows you another example, and under such radically different conditions as to lead me to the belief that this

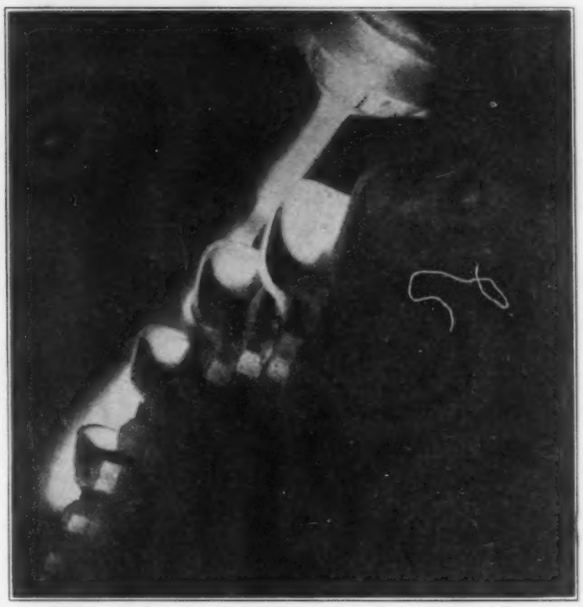


Photo M. A Stream of Water From a Pelton Needle Nozzle Under 1923 Feet Head at the Station of the Edison Electric Company, Los Angeles, Developing 86.2 Per Cent. Efficiency.

condition exists throughout the entire field of hydraulic practice. You see here a jet from a Pelton needle nozzle under a pressure in excess of 1900 feet head at the plant of The Edison Electric Company in Southern California. The jet is of a size suitable for developing an overload on a 750-kilowat generator, and the fog or "water dust" immediately surrounding the jet shows clearly the disengagement of imprisoned gas. This is best observable at from one to ten diameters from the tip, and is undoubtedly a condition that exists on the bucket surface, as well as immediately surrounding the jet at point of issuance.

Photos N and O illustrate a needle nozzle under comparatively low pressure, and the water dust is here also observable at from five to twenty stream diameters distant from the tip. In each of these cases the stream is in particularly good focus, and the water dust was more clearly observable in the investigations

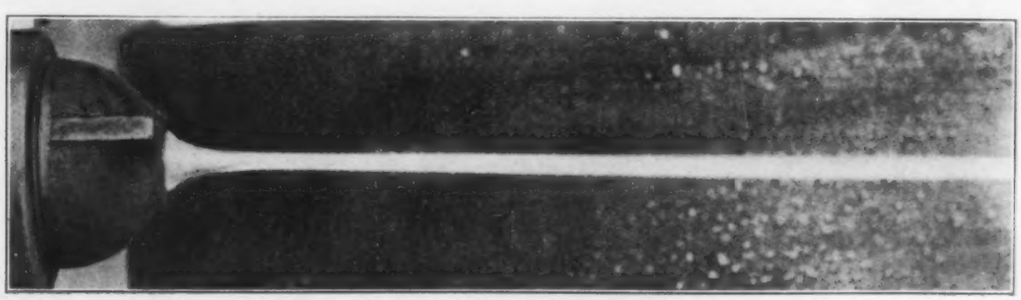


Photo N. A Stream of Water From a Pelton Needle Nozzle.

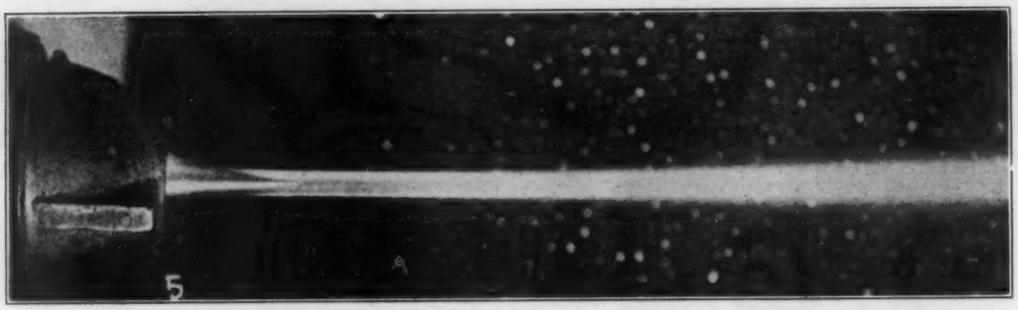


Photo O. A Stream of Water From a Pelton Needle Nozzle.

accordance with the laws of least resistance, the oxygen or other gas would be released in exactly the same way—causing the pitting surfaces inside of the nozzle tip.

I believe this to be the correct explanation of chemical corrosion, and think that in most cases in practice we have a combination of chemical and mechanical erosion.

Paint acts exactly as a sheet of paper or rubber cushion protecting a piece of glass under a sand blast—the paper or rubber not in any way being damaged by the impact of the particles of sand, but where cut away so that the glass is exposed to the cutting grains, the hard surface of the glass or of tool steel will be very rapidly cut. By holding your finger under the wheel blast, the finger nail is rapidly cut away, although the sand makes no impression on the softer skin surrounding it. The observation of this fact led the Pelton company years ago to adopt a special

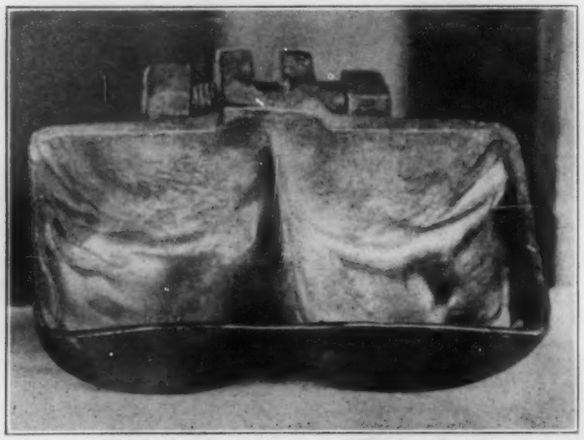


Photo P. Early Type of Pelton Bucket on Which Has Been Used Too Large a Stream of Very Gritty Water, a Combination of Mechanical and Chemical Erosion and Excessive Wear in the Corners Due to the Overcrowding With the Large Stream as Shown in Photo D. Note the Entire Absence of Wear on the Front Wall, Showing It Does Not Interfere With the Water Jet.

rule in regard to painting its buckets—the paint proving the best possible protection. In fact in regular operating plants, if the buckets are of good design and are kept thoroughly painted, they will last an indefinite length of time.

Photo P shows you the interior of a bucket, the back part of which is shown in Photo D. This bucket was overcrowded, as shown from the cutting in the corners. In spite of this the outside of the front wall is not worn in any way, due to the stream cutting the wheel. The slight wear on the dividing lip is not as great as on the dividing wedge inside the bucket. Considerable notoriety has been given by a competitor to a large Pelton bucket originally in use at the Nevada Power Company's plant on account of the unusual amount of wear on the back. This has been explained by parties unacquainted with the facts as having occurred as shown in Photo Q, Figure 4. The water does not, however, take this course through a Pelton bucket, as we have already shown you, Photo A, but takes the course as shown in Figure 5 and Figure 6 of Photo Q.

Figure 7 shows the way that the bucket in question received its wear. I have made several inquiries, endeavoring to get hold of this worn bucket to exhibit before you, but was not able to obtain it. It is no defect in the bucket curves if the back portion of the bucket is worn, due to water impact from some entirely different source than the bucket curves.

Photo F shows you a Pelton wheel in operation at the point

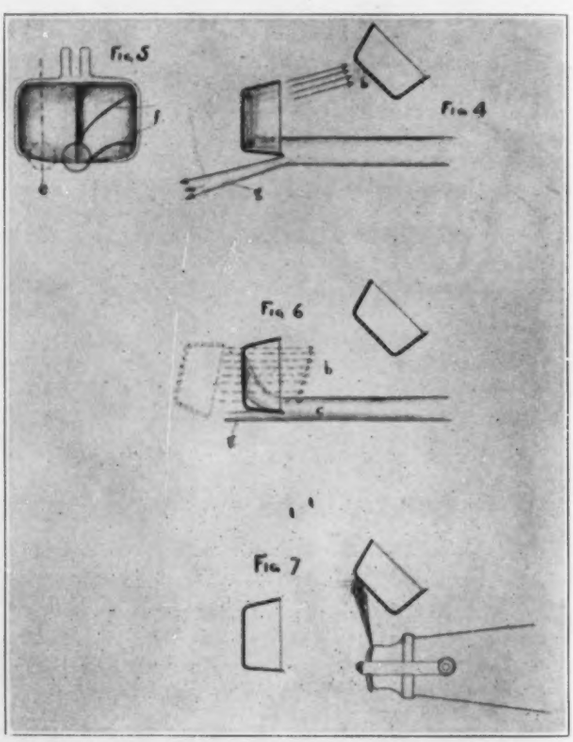


Photo Q. Figure 5-6, the Path of Water Jet Through the Pelton Bucket. Figure 4, a Diagram Sometimes Used but Incorrect to Explain the Wear That Occasionally Occurs on the Backs of Water Wheel Buckets. Figure 7 the Correct Explanation of Wear on the Backs of Well-Designed Buckets.

of best efficiency, and shows that the water impact and discharge all occurs vertically under the wheel center and within a very short arc of stream contact; that there is no disturbance occurring in the stream itself due to the front wall of the Pelton bucket entering the stream.

Photo S shows you a Dodd wheel in operation when running at its best efficiency, and showing the discharge of the water through the front of the bucket at a point further removed from the wheel center than the entering water as claimed in Mr. Dodd's patent.

This slide also clearly shows the water entering one bucket but not yet leaving it, the bucket having to advance several stream

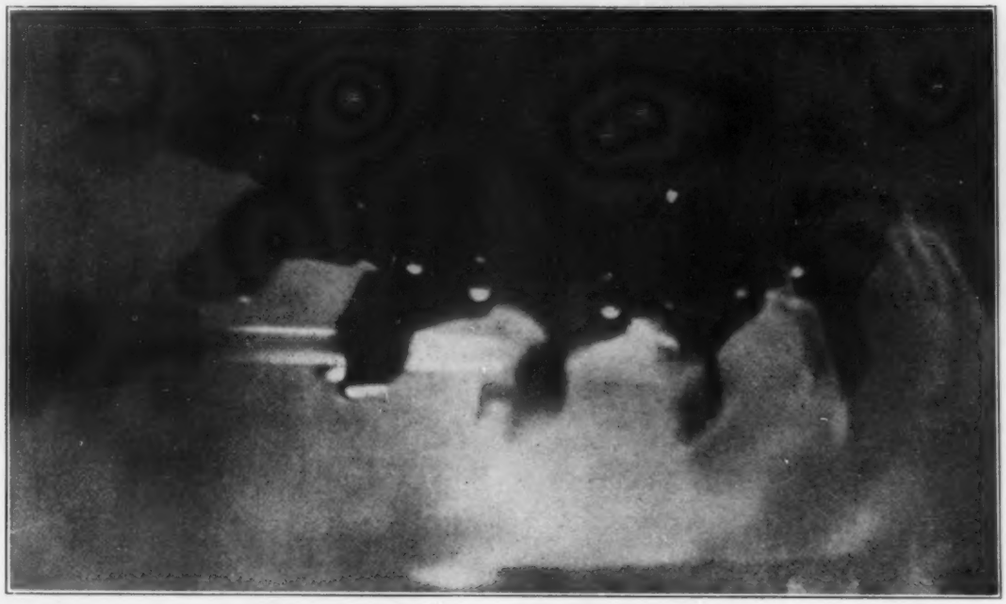


Photo S. Instantaneous Photograph of Tangential Wheel Fitted With Dodd Buckets and Running at Maximum Efficiency Showing the Discharge From the Buckets to be Below the Point of Entry and All of the Stream Fully Caught in the Buckets and Reversed in Direction Resulting in High Efficiency.

than it is shown in the photograph. It is perfectly obvious, if this theory is correct, that much of the wear that occurs in the interior of nozzle tips would also be explainable. For it is certain that where changes of cross section occur, there is a corresponding change in stream velocity, and, when this is not in diameters before it begins to discharge. The second and third buckets are also shown still receiving the stream, and the fourth bucket is shown with the water leaving it, although no water is entering.

Photo T shows a wheel fitted with ellipsoidal buckets operating at point of best efficiency. One bucket has just started to enter the stream; the second bucket is in full action, the third bucket is just receiving the last particle of water, and the fourth bucket is just discharging the last particle of water. All of the buckets show clearly the loss of water through the open front wall, as pointed out above. This water still contains considerable energy, resulting in a large falling off in efficiency. The efficiency of this type of bucket will decrease as the head decreases, the result being that for large streams under low heads such a large quantity of water is lost through the front opening as to very considerably reduce the efficiency below that obtainable with buckets having a front wall.

Photo V shows one of the Pelton buckets at the Edison Mill Creek Station No. 3, which was painted with a single coat of asphaltum varnish, allowed to dry three hours and then put under operation, driving a 750-kilowatt generator at about full load for

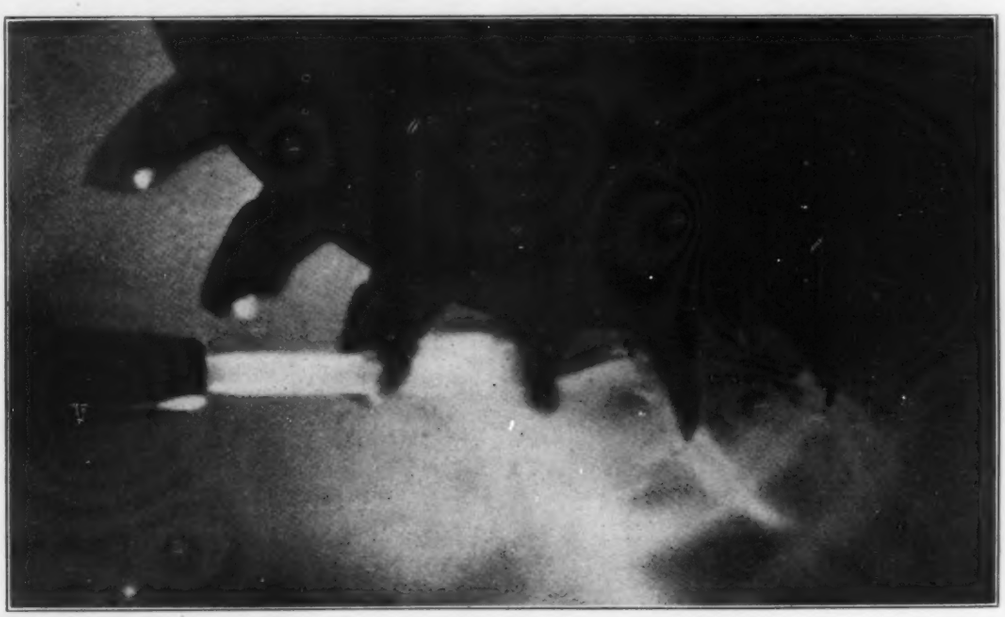


Photo T. Instantaneous Photograph of Tangential Wheel Fitted With Ellipsoidal Buckets and Running at Maximum Efficiency Showing the Losses That Occur Due to the Stream Partly Discharging Through the Front Opening Before Energy Has Been Taken Out and Discharging From the Front Corners of the Bucket, Resulting in an Unnecessarily Large Discharge Angle, Reducing the Efficiency of the Wheel.

a period of twenty hours, after which it was shut down and this photo taken. The photo clearly shows from the surfaces where the greatest amount of varnish is worn away that the discharge

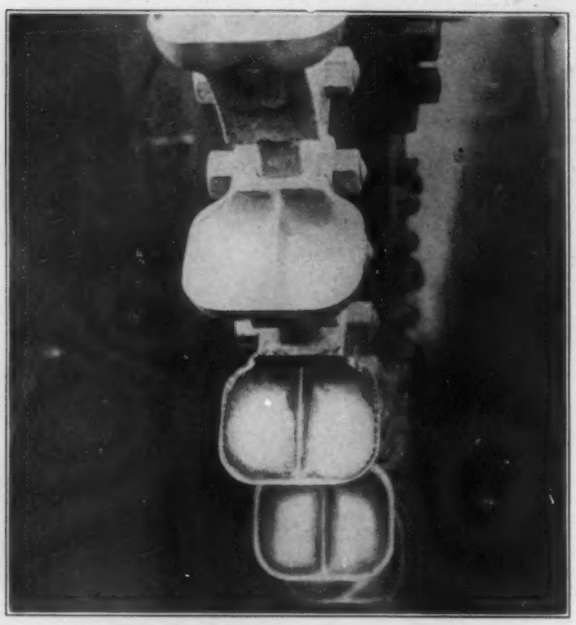


Photo V. Pelton Bucket at Edison Mill Creek Station No. 3 Showing by the Wearing Off of Paint After Twenty Hours' Run Under 1923 Feet Head That the Discharge Occurs From the Sides, as It Should for Best Efficiency.

occurred from the sides of the bucket and not from the top and front as has been sometimes claimed.

The inevitable conclusions are that the greatest care and best judgment must be exercised in designing a bucket for each case. Certain it is, the bucket should have a front wall, joining cylindrical surfaces, which meet in a central apex or wedge, as distinguished from open front types and those having cups with

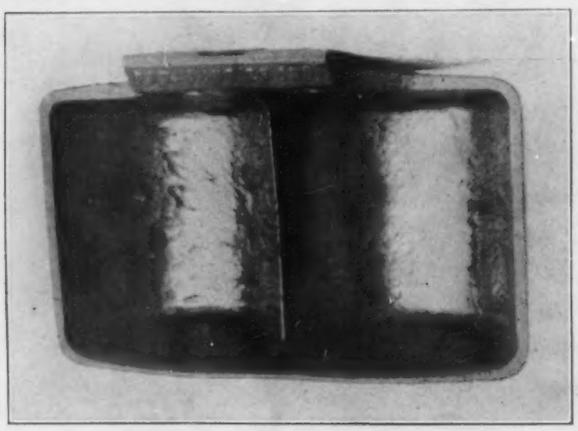


Photo W. Worn Bucket Showing Chemical Erosion Creeping Toward the Center Dividing Wedge.

deepest points in them, for the water to form eddy currents. It is a strange thing that mining companies will pay high prices for each inch of water and then use it over cheap wheels, cheap only in first cost, but probably costing hundreds if not thousands of dollars each year in their extravagant use of water. Some power companies are doing the same thing, except on a more magnificent scale. This condition of things is similar to that case, all too frequently met with, of cheap steam engines and boilers, whose extravagant use in coal constantly keeps the owner's nose hard up against the grindstone. There is, however, this difference, a good water wheel, properly set and cared for, will always be efficient, if kept in good condition, whereas a good steam engine, if not in skilled hands, is more apt to deteriorate. A little conservative figuring will frequently demonstrate, beyond a doubt,

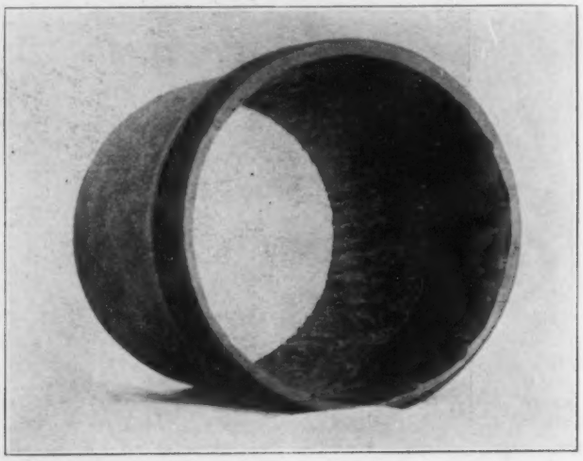
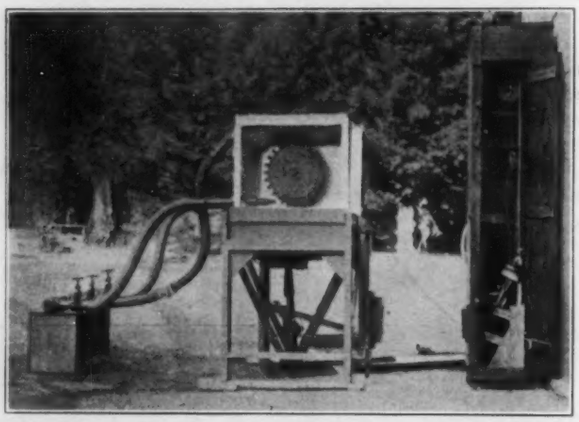


Photo X. Nozzle Tip Showing Chemical Erosion in Jar or Outlet End and Mechanical Erosion on Near or Inlet End.

that a property struggling along under a burden of indebtedness would be easily placed on a proper paying basis by the use of more efficient water wheels.



One of the Pieces of Experimental Apparatus as Used in the Investigation, Showing the Arc Light and Shutter for Illumination the Wheel and Nozzle Enclosed in a Plate-glass Case, Prony Brake and Accessory Measuring Apparatus.

COPPER MARKET SITUATION.

The copper situation reflects a distinctly cautious tendency on the part of buyers, and on that account the volume of recent sales have not squared with the records made in busy times. Mining goes right on at a heavy rate, however, and with new demand disposed to hesitate sellers beleved there were good arguments for reducing the price of Electrolytic Wirebars from 14½ to 13½. Outside of a few million pounds taken early in February by domestic and foreign interests at 13½, according to current report, and some odd sales below those figures, the market has remained very quiet.

Although the copper market has settled to a lower level, and the immediate future of the metal is enveloped in considerable doubt, nevertheless, from our point of view we look for a gradual return to brighter business conditions. Manufacturing activities are so much greater than they were a year ago that no fair-minded person of ordinary intelligence can fail to appreciate the substantial progress made towards permanent betterment.

PROCEEDINGS PACIFIC COAST ELECTRIC VEHICLE CONVENTION, SAN FRANCISCO, FEBRUARY 19-20, 1909.

DISCUSSION ON "MERCURY ARC RECTIFIERS."

The Chairman: The paper is now open for general discussion.

Mr. A. C. Downing: There is one point about the rectifier that has come under my observation particularly, the effect of the rectifier on the electric automobile business of the pleasure type. In Indianapolis there are some 150 electric automobiles in use, and there are not over 25 of them kept in a public garage; all the rest are kept at home. That is one of the most notable effects of the rectifier on the business. It also works a great saving to the owner of the vehicle, in that it is free from the extra charges that a garage will slip in. In one instance they charged four dollars a month for acid. They cannot charge that when the owner has the car at home.

The Chairman: It might be well to bring out now, if any one has anything to say on the subject, the charging by the direct use of continuous current. In many cases continuous current is available, and the apparatus required and the efficiency obtained would be interesting to know.

Mr. G. A. McDougald: What is the efficiency of the mercury arc rectifier?

Mr. Alvord: The curve showing rectifier efficiency is on one of the screens; it shows the efficiency to be approximately 81 per cent. The efficiency charging on DC depends upon the relation between the battery and line voltages.

Mr. W. W. Briggs: There is no question of the rectifier having any advantage over the DC central station service, for the reason that the city mains are generally 110-volt, and on small batteries you would have to have rheostatic control. One thing that should appeal to the central station man would be the advocacy and the development of the private garage, where the current would be used when the central station was being operated at the time of light load conditions. A man naturally wants to ride around in his wagon in the daytime, and if he has it in the garage at night the central station gets the advantage of the night charging and the man gets his vehicle when he wants it. That brings about the necessity of an automatic charging plant. I might say that we have placed upon the market now an apparatus which is fully automatic. All the private owner has to do is to bring the vehicle into the garage and attach it to the rectifier, which automatically shuts off the current when the battery is fully charged. In the event of an interruption to the service during the charging, when the current comes on again the charging will continue automatically. If the battery were fully charged the rectifier would not start. That feature will appeal particularly to the private owner for the reason that with its use there is no need of a skilled attendant.

The Chairman: That is a very important point, that the rectifier will maintain the service independent of any interruption on the lines. (Laughter.)

The Chairman: Is there anyone here who has had experience with charging batteries direct with continuous current?

Mr. W. D. Vance: In charging ignition batteries we figure on about 18 3-cell batteries, 54 batteries on a circuit; we figure it costs us just as much to charge one as thirteen or fourteen; so we always try to get a full string before we attempt to charge any.

The Chairman: Can you describe the system which is used in New York, Mr. Murphy?

Mr. A. R. Murphy: The largest consumer there is the New York Vehicle Transportation Company. They have their own sub-station. Some years ago they bought 3-phase 25-cycle power of 6,600 volts from the New York Edison Company, and if I am not mistaken they had a 250-KW rotary converter installed. They aimed to keep a constant bus pressure. I do not remember what the exact voltage was, whether it was 100 or more. Then they used six cells for their high and low bus. These cells were of a large central station type. Most of their work was automatic, and really it was on such a large scale (where they were charging 100 or 150 batteries) that it is altogether foreign to anything that we will get in this vicinity for some time. It costs just as much to charge a small sparking battery as half a dozen. The best possible way to handle it is to get as many batteries as possible on the circuit, and the charging expenses per set are correspondingly cut down. We are using the ordinary rheostat, charging from DC circuits, and it is very inefficient. We have never tried to take measurements of the efficiency, but we know from the bills it is inefficient, for we find that in the months where little charging is done the bill is almost the same; in fact, we have almost a straight line of power charges from month to month. For that reason the mercury arc rectifier in connection with AC circuits is much better, because the control is better.

Mr. A. C. Downing: Mr. Churcher, of Cincinnati, one of the best posted men in electric automobile practice, in the care and charging of batteries, uses the stationary type of cell as resistance in charging from his DC line. In that way he saves the current, and in turn uses it for charging his sparking batteries, running his electris signs at night, and so forth. I think that is one of the best schemes that has ever come under my notice, when they have the DC to handle in a public garage.

The Chairman. Some years ago, when electric vehicles were first put upon the market, it was customary to have a larger number of cells per vehicle, usually from forty to forty-four. The reason that number was used was because they could be economically charged from the ordinary continuous current circuit. Resistance had to be used during the first half of the charge to control the rate and later the full voltage was put on to the battery. Since that time the electric vehicle people have found it more desirable to reduce the number of cells to, in some cases, thirty and twenty-four, and in other cases fourteen and twelve. That has changed very much the charging methods and has made the mercury arc rectifier very much more desirable.

Mr. F. T. Kitt: I would like to ask Mr. Alvord how much energy is wasted in resistance on that large set shown last. I believe there are two circuits in that, aren't there? And the one you have to have resistance in to cut your voltage down. You have practically the same as the direct current. You cannot vary the AC without interfering through the batteries charged except by resistance.

Mr. R. M. Alvord: That panel which we call the garage panel consists of a forty-ampere high-voltage rectifier panel and a distributing panel. The idea is to charge two sets of three batteries each. If you have three sets of two batteries each, which are practically the same voltage, there is practically no waste in the rheostat, because the voltage can be so set that there is no waste. If you were to charge three sets of batteries on one side and two sets on the other, the use of the rheostat is to equalize the voltage between the two sides, and the loss is to that extent.

Unknown: Before adjourning I would like to ask what would be the effect if a large store like the Emporium used a lamp that would utilize the light given off by the rectifier, thus lighting its store and charging its battery at the same time, lighting the store practically free of charge. Could that be worked up in any way?

Mr. R. M. Alvord: One of the uses the rectifier is sometimes put to in a garage is to put it in the window. I know several places where they use the rectifier in the window. They do their charging right along and at the same time the peculiar color of the light attracts attention and advertises the garage.

Mr A. G. Jones: As to the lighting of a drygoods store the mercury vapor lamp would be of little value. It is very important in a drygoods store or any place where color values are to be taken into consideration that a light producing more nearly the qualities of daylight is to be preferred. In a mercury vapor lamp the rays are practically devoid of red rays, and therefore it is not very satisfactory in any place of that kind.

Mr. F. T. Kitt: This gentleman thought that in the Cooper-Hewitt lamp there would be considerable waste of power, and in the mercury arc rectifier the light is wasted. I think in the Cooper-Hewitt lamp this is a very small loss of power. In the mercury arc rectifier the drop in the tube is very small, the amount of waste in the tube is very small, and consequently the light cannot be very great.

Mr. A. H. Halloran: The question seems to be one largely of auxiliary apparatus. The Cooper-Hewitt lamp would be a very small part of the mercury arc rectifier. The main function of the rectifier is to furnish direct current, and the auxiliary apparatus is so designed as to be efficient and furnish the direct current as cheaply as possible, and the lighting effect is not sought. Photographers are using the Cooper-Hewitt rectifier occasionally, but in so doing the Cooper-Hewitt lamp has been made efficient and does not employ all the auxiliary apparatus that is employed by the arc rectifier. The suggestion that a drygoods store be illuminated by the Cooper-Hewitt lamp is hardly feasible excepting in a window display or something of that kind to direct attention by the peculiar color of the light. The drygoods stores are installing tungsten lamps, or some form of lamp that will render the true color values of the goods. Would it be practicable to put a mercury arc rectifier on the vehicle? While the owner is getting his lunch his battery could then be charged.

Mr. R. M. Alvord. The rectifier device that is used for electric automobile charging now weighs 700 or 800 pounds, and

it is just a question of designing the machine whether it would be practicable on the machine or not. I believe there is some use being made of the rectifier in connection with transportation problems, but not on electric automobiles.

Mr. G. R. Murphy: Could not that weight be materially reduced?

Mr. R. M. Alvord: I doubt very much if the weight could be materially reduced. The metal casings and the panel would probably reduce it to 500 pounds.

Mr. F. T. Kitt: I would say that I think that could be done. You can get the 220 volts; you can charge the battery with a bare tube and a little resistance. I have run a tube just for an experiment right off a three-wire system on the house without any transformer, except a small induction to smooth out the wave, and it worked very successfully; but I think a good many tubes would be broken.

Mr. W. W. Briggs: I think some experiments have been made on those lines. The limit is the lamp tube, and I think the General Electric and the Westinghouse have been working on the lines of a bulb instead of a glass, so that it will be more rugged for a rectifier. That is very much in the future.

Mr. A. H. Halloran: Recently silica has been used in the manufacture of chemical apparatus. It can be heated to a high temperature and dropped on the floor without breaking, and it is possible to substitute it for glass in many chemical cases, and it is quite likely that it could be used in the mercury arc rectifier tubes.

The Chairman: If there is no further discussion on this subject I would like to bring before you something that has occurred to me, and that is, that we might possibly form a permanent organization, call it the Pacific Coast Electric Automobile Association, or something similar to that; the purpose being to promote the use of the electric vehicle. Along those lines, if that meets with your approval, I would suggest that you in some way select a committee at this time—maybe three—to draw up, at least temporarily, some by-laws, and to submit them at our dinner to the delegates on Saturday night. At that time we can adopt the by-laws and elect officers. What is your pleasure in this matter? You have ample time between now and then to do all the electioneering you want to.

Mr. Kitt: I believe that would be a very good scheme, and believe that you know the men here better than anybody else and could therefore select those best fitted for the purpose. I move that you appoint a committee for that purpose.

Mr. George C. Holbuton: I second that motion.

The Chairman: It has been moved and seconded that the chair appoint a committee to draw up by-laws for a permanent organization.

The motion was formally carried.

I will appoint on that committee Mr. Kitt, Mr. Downing and Mr. Halloran.

The next paper is by Mr. Murphy, and as it is now late, nearly lunch time, it might be well to adjourn and come together at 1 o'clock.

DISCUSSION ON "VEHICLE BATTERIES."

The Chairman: The subject of batteries is now open to discussion.

Mr. F. T. Kitt: I would like to ask Mr. Murphy about freshening charging of batteries, as to how much that should be carried out when a battery is not in use.

Mr. G. R. Murphy: That depends on how much it is out of use. I should say in a general way that if a battery is out of service about two weeks—not used during that time—I would give it a freshening charge at the end of that time. I would not put any time limit on it at all, but I should say that it would take anywhere from one-half hour up. It might be that there is a large amount of sediment in the cells, and it might take a longer time to bring it up than if the cells were clean.

Mr. F. T. Kitt: Just simply bring up the acid and the voltage?

Mr. Murphy: Yes. It is well to follow both, as one will serve as a check on the other.

Mr. F. T. Kitt: I have a battery not in use for a long time, and when I would charge it up the voltage would come up in half an hour. I do not know whether to leave it on longer than that.

Mr. G. R. Murphy: Sometimes in an old battery it takes much longer. I would not let a battery go without charging it at least once in two weeks. In sparking batteries, where the discharge is low and where they are discharging all the time, they might not have to be charged for six or eight weeks, but I am speaking mostly of propulsion vehicles.

Mr. A. H. Halloran: One of the principal objections to the use of the storage battery in electric automobiles is that of weight. One-third of the weight of an electric automobile consists of its battery, and to eliminate this so-called fault a great many attempts have been made to find a more efficient battery than the old one. One of the best-known is the Edison battery. The positive and negative plates are perforated nickel-plated iron. The positive plate perforations are filled with oxide of nickel and pulverized carbon, the latter to increase the conductivity. The negative plate is made of oxide of iron, and pulverized carbon is also added. The electrolyte consists of 20 per cent. solution of caustic potash (KOH). It is not dissipated, merely acting as an agent to carry the oxygen from the positive to the negative plate. The charging current enters the positive plate and in so doing oxidizes the nickel to and reduces the negative plate to spongy iron. The main advantage that the Edison people urge is that of great voltage capacity per unit of weight. The watt efficiency is 60 per cent. The weight of efficiency is from 11½ to 13½ watt hours per pound. That basis of reducing the number of watt hours to pounds has not been brought up by Mr. Murphy, and if he would make such a statement it would probably give us a good idea of the relative efficiency. This question of weight, however, is not as important as is usually figured, and probably does more harm to the electric automobile industry than any other question brought up, because every automobile has to have a certain weight to impart the necessary tractive effort. I would like to ask what the weight efficiency is of the old storage battery.

Mr. G. R. Murphy: I do not remember. I have not the figures here. I think Dr. Kennelly read a paper in 1901 on the nickel and iron cell, and I think the discussion brought out that the voltage of that type of cell had a much lower limit. For the same kilowatt output and for the same voltage you would need a greater number of cells; I think the weight of efficiency is much lower than the lead, but I do not remember the exact figures.

Mr. A. C. Downing: I have some data on the Edison battery as compared with the standard lead. In my experience in selling automobiles I do not know of anything that has held back the sale of machines more than the publicity given to the Edison battery by newspaper writers that are exploiting and have to have stories to keep their jobs, and there has been a good deal put out that there is absolutely nothing to, and some of it, of course, is what we all hope will be some time. But here are the comparisons: The capacity is rated at 25 amperes for six hours. The first discharge was 25 amperes for 5½ hours. After 100 discharges it gave 25 amperes for 4½ hours, showing a great drop in capacity. The evaporation is one of the great things we have to contend with. In Washington, D. C., the Adams Express Company are using Edison batteries exclusively; they have to fill their batteries about three times to twice with the ordinary lead plate. That entails quite a deal of work over the lead plate. In regard to the sediment: The pockets that you speak of are intended to be everlasting as near as a mechanical proposition can be, and after a hundred discharges they found there were five grams of sediment. That is practically nil. The temperature after a hundred discharges was 100 degrees Fahr. That, of course, will remain approximately the same as the other. On the test the separation of grid and material was lower. Of course, that was due to the action on those grids. The foaming is a serious trouble on account of the corrosive effect of the fumes. That was found in handling those batteries in quantities. They have on the top of the Edison cell an automatic valve so as to relieve the gas, because when the pressure becomes so great it had to be relieved. If it did not, the cell would blow up. I had occasion to sell four machines in one city and there would hardly a day go by for four months but it was necessary to send a new cell down there for one blowing up. Another experience we had was, the first cells were made with soldered joints and the solder was affected by the acid, and the manufacturers changed to an electrically welded jar. They changed the cell afterwards. The watt efficiency of the lead storage battery is 75 per cent., and the Edison 50 per cent.; therefore the Edison requires 50 per cent. more current. The voltage potential difference of Edison is 1.2, the lead 1.96; therefore 1.04 more. The design of the vehicle would have to have considerably larger carrying space for the Edison battery over the exide. The exide is equal to the Edison for weight for equal capacity and occupies 60 per cent. less space and costs only about one-half of the Edison battery. So that really, when it comes down to the present basis for renewing the plates there is not so much gained on his proposition.

Mr. A. H. Halloran: The inference at present is, then, that nothing is as good as the lead cell. There are many inventors at work on the idea of making a storage battery of light weight and so compact that it will take even less space than the present battery. Without entering into any further discussion, I think the success of the electric automobile will be greater when a lighter storage battery has been developed, but it will be a matter of time before that takes place.

Mr. G. R. Murphy: With the exception of possibly one cell, the Edison cell, nearly all the batteries in the world today are the lead, lead peroxide, and nothing today has been found either by the manufacturers in this country or on the other

side that is better. The improvement being made today is more in the perfection of the plate itself; in other words, the plate itself has been made for some time along the same general lines, but the improvements have been in perfecting the material itself. Naturally, all the manufacturers would use any other element that would produce the same results as lead, with less weight. With the exception of the Edison type I know of no battery today other than the lead-lead peroxide being manufactured.

Mr. A. H. Halloran: The trouble with the copper zinc battery was that it was not practical. In some way it was attempted to use the Edison-Lalande cell as a storage battery, but that has not proved satisfactory on account of its low electric motive force. But I feel confident that it will be but a comparatively few years when there will be something used that will give a lighter battery. When that is finally accomplished even the last objection, of weight, will be removed.

Mr. A. C. Downing: If you take into consideration the electric automobiles produced eleven or twelve years ago and the electric vehicle that we have today, and think that in that time there has been an increase of life and mileage of over 200 per cent, we are going at a very rapid stride as it is.

The Chairman: I would like to make the point again which I did this morning, that this increase of two to three hundred per cent. in mileage is due largely to the perfection of the running parts of the automobile and only slightly to the decrease in weight of the battery. The greatest decrease that has been made in the battery has been made just this last year. The output of the battery has been increased about 25 per cent. per unit of weight during the past year, and even in spite of that we do not notice any radical change in the electric vehicle business. It has been all due to the perfection of the tires, motors, bearings and so forth. I might add that the battery seems to be the most simple thing. The lead battery consists of peroxide as a positive, and spongy lead as a negative, and it would seem a very simple matter to combine these two in proper form, but people who have experimented with batteries have experienced all kinds of difficulties on account of the chemistry of the battery, the reactions that take place in the cell. The condition of the plate changes at every stage of the discharge. If you take the negative plate out into the air it oxides. As we select lighter metals for the elements we must increase their volume. For instance, Edison's battery, although lighter per cell, requires a larger number of cells and a larger volume, and the net weight is just about the same as in the lead cell. Therefore, the lead cell is better because there is the same energy in less space. When you get to making lightweight cells—of course, you can do that if you use a very superior quality of material, but usually the factor of safety is reduced with reduction in weight. This applies to machinery as well. Probably the machinery men here can corroborate me.

Mr. W. W. Briggs: I believe you are right there. As far as the commercial point of view is concerned, we seem to be losing track of the reasons of this gathering. I have been listening to Mr. Halloran, but we should consider the commercial end, the possibilities of enlarging the use of apparatus, assisting the central station man, the electric motor man, and along that line. I think two-thirds of the trouble with electric vehicles has been due to the way in which the matter was presented to the public in the early days of the electric vehicle business. Some few months ago I had some interesting correspondence with Mr. Eames, who was at one time handling our electric vehicle business, and I do not think there is anybody in the electric traction business that has given the matter the study that he has. In some correspondence I had with him with reference to the possibilities of electric commercial wagons he brought out several points that laymen would overlook. We have had several examples of the improper application of vehicles in this city. You probably remember in the early days the cigar dealer who bought a very heavy vehicle for an advertisement. If he had bought a two-ton vehicle instead of a seven-ton, it would have been better. All he had to have was a wagon that would carry around a sign. In this correspondence I was asked the question by a prospective customer how far an electric vehicle would go up a 15 per cent. grade. I passed that up to Mr. Eames. He said a certain size vehicle will go up a 15 per cent. grade for six miles, and if you will add up this distance of grade you will find that you have a pretty high hill.

In these days a man, in the selection of a vehicle, will guess at what he wanted. A brewer guessed he wanted a six-ton vehicle. In loading or unloading that vehicle it will take a certain time for the driver and that period of loading and unloading the car inoperative. If he got a three-ton wagon it would go over the ground faster and deliver twelve tons instead of six. In the early days these questions were not considered, and they were condemned, not because they were electric vehicles, but because they were not suited to the duty required. So the necessity exists for a careful study of the immediate needs of the man who proposes to use an electric vehicle. I suppose it will take some time to remove the bad taste in the mouths of the men that used it once. However, it can be demonstrated that the electric vehicle is the right thing, and with the batteries and motors, etc., that we have, it is something that we can make money on. So we are not going to lose anything by developing what we have, and we can hope for something better in the future.

The Chairman: Mr. Briggs' point is well taken, but the point that Mr. Downing and I wanted to make was that if people have in their minds that just about tomorrow or six months from now somebody is going to get out a battery, half the weight of the present standard battery, he is going to wait that six months to get a vehicle with that weight of battery in it. I believe all the discussion tends to show, and I know that all our experience tends to show, that no revolution in the battery business is going to happen. It has got to be a gradual evolution. If the battery that is out today will carry a vehicle say seventy miles on level road, it is all that you want one vehicle to do in one day, on one charge, about the city And it is not a touring car; the gasoline is the touring car. I will announce now that tomorrow afternoon Mr. Harvey, who has a Baocock electric, will give a demonstration on Powell street hill. He will run his vehicle up and down as many times as anyone wishes. This demonstration is to convince a good many people in San Francisco who are not informed, that an electric vehicle will climb hills. That seems to have been the bugbear in San Francisco for a number of years.

Mr. A. E. B. Ridley: The real trouble with the earlier electric vehicles was not with the storage battery or the motor, but in the inherent trouble. The cigar wagon troubles were with the ball-bearings joining the motor with the gear on the outside to propel the vehicle, and also the small size of the hard rubber tires. They used to get into a rut and that would take the entire tire off, and there was only one place to repair it, and they were out of rubber generally. Also the ball-bearings. The batteries gave little trouble excepting the terminal connections. The connections between the cells were very badly put together; in the old times they wobbled about. The ball-bearings between the motor and the guiding gear were always breaking up, sometimes being crushed. Those were the two principal troubles. But with all those difficulties we ran that vehicle for twelve months and it did good service.

Mr. Harvey: The gentleman who spoke a while ago made a remark about the capacity of the car, that is, that it was not the fault of the electric automobile, that the man loaded it down, that he got a heavy truck to carry a certain load, but that the man got a truck that was too heavy, that he should have got a lighter truck. In selling gasoline trucks for a number of years, I think that Mr. Briggs is entirely wrong. I have sold cars here that we call thousand-pound wagons, and when we were called upon to see what was the matter we found they were trying to use it for 2,500 pounds. When we sold a 2,500-pound wagon it was expected to carry 7,500 pounds. Every time we had an accident we found that was the case. I think Mr. Briggs is entirely wrong in regard to getting over the ground faster. What he wants is a heavy truck to carry five tons that is capable of carrying 20 tons.

Mr. Briggs: I did not lay that down as an absolute rule. If you get a truck that keeps a driver going, the truck that will keep him driving most of the time, that is most efficient; but if you waste time in loading and unloading, your vehicle is inefficient. The rule has to be modified to suit a man's particular requirements. My idea is the need of careful study of a man's actual conditions. If a man is going to handle heavy machinery he should have a heavy truck, but if a man is going to handle empty cigar boxes he would have a hard time in getting a big load The application of a man's trucks should be made to a man's need, and not the man's needs to the truck. There is no question as to the need of having a heavy truck to handle heavy pieces.

Mr. W. L. Harvey: A drygoods firm that will buy a thousand-pound wagon and never has before handled more than a thousand pounds, if he has an automobile will get twenty-five hundred pounds on it. If you take a horse and buggy, the statistics of the United States show that the ordinary radius of a horse is fifteen miles per day. With our electric machines it is thirty to fifty miles a day. We go to a man and we say, "We can take and put you in a machine that will deliver a certain amount of goods in a given time that two horses driven single will do." Immediately that should convince him of the fact. He says, "If you will agree to furnish what two horses will do," and he immediately piles up what four horses will do. That is what we have been up against all along. Take the Emporium and Roos Brothers. Roos Brothers are the only firm that acknowledges positively and actually that they put out

four horses with a single machine. A single machine did all their work on Saturdays which five horses used to do. They had the sense to employ a good man to drive that machine. The result was that we got good benefit from that. Then we went to the Emporium, and they wanted to get a boy to drive the machine, where it takes a first-class machinist to do it. And with the electric vehicles we are going to find the same experience. When we tell a man we are going to give him a vehicle for 500 pounds and then give him a 2,500-pound machine, we will meet the objections.

The Chairman: We are getting off the subject of batteries. We will be glad to hear of your troubles with batteries.

Mr. I. G. Perrin: While on this particular subject I wish to agree with Mr. Harvey in the respect that trucks are almost always overloaded. One point not touched upon is that nearly half the time these trucks are running empty, and I believe consideration should be given to the fact that two-thirds of the expense occurs with the car running empty. That is the reason that the smaller truck works out to be more efficient than the larger ones.

The Chairman: If there is nothing more to be said on batteries we will go to the next paper.

Mr. C. O. Wilson: There is one objection to electric vehicles and that is the washing of the batteries. A great many people, when you tell them how often the battery has to be washed, seem to think that is a great expense when you tell them what it is going to be; and I would like to ask if there has ever been any work along the line of doing away with washing so often as is at present necessary. Should you wash a battery two or three times depending on how it has been used? There are a great many people who object to that. It probably lays up the vehicle for a couple of days, if you did not happen to have a fair battery; and a great many of the doctors and business men need the machine right straight along, and it throws them back a great deal. What I would like to know is if there has been any work along the line of doing away with this washing. Did not the Willard people put a sort of rubber around the plates to keep the material from depositing in the bottom of the jar to prevent the necessity for washing?

The Chairman: The Sperry people had an envelope, but it stopped the circulation of the electrolyte next to the plate. Mr. Stevenson, you can tell us something about washing batteries and how long it takes to wash them.

Mr. P. M. Stevenson: I do not feel very much like talking, but I am willing to answer any questions. I have handled a good many batteries in seven years, vehicle batteries especially. In washing batteries I do not think it takes very long —two days. There are other things that tie a car up longer than that. I have about sixty to take care of and I never have any objection about the battery washing in any way. Some people do kick a little about the expense, but it is not great in comparison with other things.

The Chairman: Of what does the expense consist—in the time and labor?

Mr. P. M. Stevenson: It is mostly labor, where you are using the old separators and electrolyte.

Mr. G. R. Murphy: Have you a flat charge for washing?

Mr. P. M. Stevenson: Yes, about 90 cents a cell and material extra. That is, for labor, 90 cents a cell.

Mr. G. A. McDougald: Does that include the labor of washing the cells?

Mr. P. M. Stevenson: Yes. The total runs up to a little more than a dollar a cell, putting in new electrolyte and separators.

Mr. G. R. Murphy: Are there not some people in Los Angeles who make a flat charge?

Mr. P. M. Stevenson: Yes, I think so. They charge a dollar a cell; but then you do not get a very good job.

Mr. G. R. Murphy: Did they not make a flat charge of twenty-five dollars for thirty cells?

Mr. P. M. Stevenson: I have not heard of any. There are people who make a flat charge, but I have seen several that have been washed that way, and they have always been slighted.

Mr. W. W. Briggs: About how often does that washing have to be done?

Mr. P. M. Stevenson: I find that we get on an average about three thousand miles on one washing. We get as high as eight to nine thousand miles out of the battery, and we wash it usually three times.

Mr. G. R. Murphy: At the end of about each three thousand miles?

Mr. P. M. Stevenson: The battery will only stand two washings. It runs until it gets dirty the third time, when it will hardly pay to wash again.

Mr. G. A. McDougald: What kind of skilled labor does it take to do that, for the labor of washing them out and burning the connections?

Mr. P. M. Stevenson: It does not take much skilled labor, one man who understands the business. It is simply directing. A man needs just a little instructing. Burning needs some practice, but almost any man can do the other work.

Mr. G. R. Murphy: Eight or nine thousand miles is as much as you obtain from a set of positives.

Mr. P. M. Stevenson: We never set up a negative after eight thousand miles. The negatives give out before the second set of positives do. We have had cases where a battery has not been used properly where the positive plates would give out at about 5,000 miles. Then we would use the old negatives and we would probably get 5,000 more.

Mr. W. W. Briggs: Is there any value in a discarded plate?

Mr. P. M. Stevenson: You would have to ask the electric storage battery people about that?

Mr. G. J. Brand: Can the old plates which are thrown out be used over again? Can they be made use of by putting in new active material?

Mr. G. R. Murphy: No, that is not feasible. It has never been a success. It is far easier to put in a new plate.

Mr. G. A. MacDougald: How often do the separators have to be changed, Mr. Stevenson?

Mr. P. M. Stevenson: I find it is better to change them every time they are washed. I have washed batteries where I would leave in the old wood separators, but trouble would always come from it.

Mr. W. D. Vance: From the breaking up of the separator?

Mr. P. M. Stevenson: Yes, usually that way. In disturbing them they would get broken. I would not have to replace all of them, but you have to be very careful, and I find it better to replace them.

Mr. W. D. Vance: Do you find it necessary to take the positive and negative elements apart?

Mr. P. M. Stevenson: I do not always remove them if they have not been damaged in any way. I get a good many batteries that people charge themselves, and I find that you have to have new separators if you get a good job out of it.

Mr. W. D. Vance: Did you ever run into a set of separators that have been punctured, apparently burned through?

Mr. P. M. Stevenson: I have found several that way. A good many times I have found a small piece of lead packed in with the separator which caused a short circuit that burned out the separator.

Mr. W. D. Vance: I had a case where every separator was punctured through in several places. It looked very much like the hole that a static discharge would make, and I never could understand what the trouble was.

Mr. G. R. Murphy: I have never seen that case. Was there any rubber separator used?

Mr. W. D. Vance: No, there was no rubber.

Mr. G. R. Murphy: That might possibly be it. It might have been pressed up against the positive plate. For that reason they use the perforated rubber sheet as a protection to keep the wood separator away from the surface. It is not so necessary in a smaller battery.

Mr. G. J. Brand: What is the objection to all-rubber separators?

Mr. G. R. Murphy: The objection against all-rubber separators is the fact that they have to be perforated, and as the material is washed out it is bound to lodge in those perforations and bridge across. The wood separator does away with all troubles of this character.

Mr. G. J. Brand: I found one mechanical trouble, that the separator had not been made to fit just right.

Mr. G. R. Murphy: We have had a little trouble of that kind in sparking batteries that was due to the separators not being of sufficient thickness for the separation of the plates. That has been remedied. I do not think you will have any more trouble of that character.

The Chairman: In going about I have had different people tell me of many different lengths of time that it takes to wash a battery, and they state all the way from two days down to less than half a day. I was told in Long Beach that they could take in a vehicle, wash the battery and send it out inside of half a day. I want to know if there is anyone here who can do that?

Mr. P. M. Stevenson: I know just how they do that. They will pull out the elements, wash out the jars, fill them up again, and burn them together and slide them right back in the rig without examining them, charging a flat rate of so much a cell.

The Chairman: They do not take the plates apart?

Mr. P. M. Stevenson: No.

The Chairman: In that way they do not have to remove the separators?

Mr. P. M. Stevenson: No; they simply wash out the jars.

The Chairman: They simply remove the sediment from the bottom of the jars.

Mr. Brand: There is really no value in it. The plates might not have time to discharge, but they cannot very well use the same electrolyte.

The Chairman: Mr. Perrin, how long does it take you to clean a battery under the best conditions?

Mr. I. G. Perrin: I have always been under the impression that it was very advisable, in fact, quite necessary, to give the battery one slow discharge and possibly two discharges to bring it up after the elements have been exposed to the air, but I would like to have an expression from Mr. Murphy in regard to the first washing, where the washing of the battery is done by just simply taking the elements out and dumping the sediment and not disturbing the elements or the wood separators. That is, on the first washing, and I want to know if I am correct in thinking that the life of the negative plate would be twice or nearly twice the length of the life of the positive plate.

Mr. G. R. Murphy: In regard to the washing, I think I agree with Mr. Stevenson. It is simply a question of how you want to do it. I do not think in the first place that a good job can be done reasonably in less than a day. That is the minimum, and it is pretty fast work; it would take nearer a day and a half to do the work properly. The proper way to wash a battery is first to charge the battery up, and on removing the elements from the jars it is simply a question of your own judgment, that is, how the separators look. If there is any mechanical damage to a separator I would say put in a new separator right away and not run any chance of having a bad cell later on. It also depends, I think, on the rig, whether there would be any mechanical injury to those separators. If you have a rig that is not an easy running machine there might be some tendency to damage or split them. I do not think it is necessary to remove all the separators, but I think you will find always that a small percentage needs renewal or fixing up. After cleaning, the amount of charge that is necessary depends on the method in which the work has been handled. If your negatives are kept reasonably wet an ordinary charge would do. If there has been any tendency to dry out, then I think a longer charge is necessary, and it might be well to follow this up by a discharge for capacity. Ordinarily, if the negatives are kept reasonably wet I do not think that discharging is necessary. As far as the life of the negative plate is concerned, it is pretty hard to say what it is in miles. And it is pretty hard to compare it with the positive plate. The life of the positive, in the first place, is a function of the number of the charges. A positive plate is good for 300 charges. If you get an ordinary life out of a set of positives —that is 300 charges—I think your negatives will be good for one and a half to one and two-thirds of the life of your positives. The whole thing comes down to a personal equasion of just how it is handled. Mr. Stevenson brought up the point that in their garage they preferred to put in a new negative at the end of the first set of positives rather than to interfere with the working of the second set of positives at some midway point in their life. Of course, you could work that negative material to a greater extent, possibly 60 per cent. I think that answers your question.

Mr. I. G. Perrin: I think it does. If reasonably sure of the set of positives throwing the whole thing out of balance, unless one is reasonably sure of working out two sets of positives.

Mr. G. R. Murphy: The bad feature of putting in new negatives too soon is that you do not work out your investment, and on the other hand you have to give them a full initial charge with positives partially worn. That is not true of positives. Still, that condition could be done away with if you happen to have an old set of grids about, charging up the negatives with them. That is a condition that could be easily met.

The Chairman: These methods come down to a question of practicability. The battery man naturally runs everything—the vehicle and his customer—to fit the battery, whereas the customer makes the battery run to fit his desire. We find this obtains not only in the vehicle business, but in the central station business, and the practical solution is, I believe, to make the renewals of the battery, the washings and the repairs of the vehicle conform to the desires of the user and make the vehicle the most convenient thing for him.

Mr. G. R. Murphy: I would like to ask Mr. Stevenson, in washing a cell, what does he pay for lead burners? What is the difference between Los Angeles and San Francisco?

Mr. P. M. Stevenson: Just working at that trade alone, fifteen to eighteen dollars per week. Very few of them do it for much less than that. What you would call an excellent lead burner. I do nearly all the lead burning myself.

Mr. G. R. Murphy: Can you get men?

Mr. P. M. Stevenson: There are a few, but as a rule, if they can do that they do not want to do anything else.

I was going to say something about batteries. Some manufacturers of electric vehicles do poor burning of battery connections, causing plates in certain cells to deteriorate rapidly. In talking about washing the battery, the battery should be taken down when washed the first time, because you will find several defects like that. We have had such things as even reversed cells come in a new battery that is supposed to have been tested.

Mr. Scraba: I would like to say that I think a man that has got a discarded cell has got to look at the washing and renewal business in a little different light than the man in the shop. I think the first washing can be done and at a small profit at a whole lot less than 90 cents a cell. I think it can be done on a new battery—well, for a 24-cell battery, for ten dollars easily. I am saying this because when you sell a man you have got to tell him approximately what it is going to cost him. As far as renewing the positive at the same time that you renew the negative, because a negative will not outlast two positives, I do not see the point. For instance, if you put in a new set of positives you have got to open the batteries three times for washing, and at the second washing I do not see why you cannot put in new positives at that time. You have got to keep the proposition on as economical a basis as possible. I think those who are selling cars have to consider this point rather than try to keep the cars running up to their full capacity at all times.

Mr. W. L. Harvey: The oldest storage battery that I have ever heard of is one that is contained in the human breast. It is called the heart. We have mechanics called doctors. In due time the human electric automobile begins to show the effect of wear and tear. The battery needs washing. The quack gives you a dose of calomel and turns you loose. In two or three weeks you are again run down, and commercially speaking the human heart is not for sale. The commercial vehicle is called the electric automobile—the heart of the automobile is the battery. The ordinary man who will take the battery from the machine and half wash it, just give it an overlook and put it back is a quack. The man who is selling that machine and to influence his sale insists that his machine can be taken care of so much cheaper than the other man's car, simply because his battery does not have to be taken care of, is also a quack. There is only one way to look at the proposition. We are selling electric automobiles as a commercial commodity; we are selling them to make money; and when we sell a man a machine we want to be able to look him in the eyes the next day or six months afterwards and be glad to meet him, and not run around the corner and dodge him because we have given him a gold brick. The man who sells an automobile has a certain moral obligation put upon him. That man must explain to the customer who buys that his battery has certain deficiencies; it must be looked after; it must be washed; and in putting in the initial charge after the washing it takes a certain time to do it. I used to engage a horse and buggy by the month in my business, and when my horse was sick I would go down to the stable and raise the dickens. I found I could take the street car for a day or two until that horse was put in proper condition. With the automobile it is the same, your customer is the same as I was; after he buys an automobile he could not get along twelve hours without that machine; he has got to have it. It is up to you, gentlemen, to tell him that he cannot have it until it is properly fixed. The great trouble with the electric automobile is that you are trying to turn them out too quick, you did not half fix it—you are quacks. When you sell a machine explain to the man that the heart of the machine is the battery; the battery has to be properly taken care of, and at certain periods you have got to have that battery in your place and it is going to take time. Impress it on his mind and he will know it. He will kick when you have to fix it, but when you have fixed it properly and turned it out that way he will be a friend of yours for life. But if you take a hurry-up job from him and wash it in six hours or twelve hours you might as well stop doing business, because you are going to invite trouble for yourself. After it has been washed a battery is like a new machine, it has got to have the same initial charge; it has got to be charged and then drawn out; you have got to do it with proper amperage; it has got to be done properly or you will have the machine back on your hands. You have to educate your customers that at certain periods you have to do that, and you have to do it right. If you do not you are going to have a continual run of kicking. Everybody will have a hammer out for the electric automobile. I believe that every one of them is properly built; every one of them can be made to run its full guaranteed distance every day. It is just simply a matter of taking care of the battery. And when everybody makes up his mind that such things have to be you are going to have pleasure in selling electric automobiles, and you are going to make friends of those you sell them to. (Applause.)

Mr. A. C. Downing: Following up what has been said:

The best example that has come under my notice of such work is that done by Atwood, of Toledo, Ohio. Mr. Atwood appreciated the point Mr. Harvey has made after knocking around the country for several years fixing up troubles with storage batteries and decided he would open an ideal garage in a city. He selected Toledo. There were not, at the time he went there, twenty-five electric machines. In his selling program he outlined (just as has been suggested) to the customer what a battery needed, and he went one step further: He had an extra battery, and whenever a man's battery needed washing he loaned him that extra battery at a nominal charge, say a dollar a day for the time his battery was laid up. As a natural consequence, he could have proper time for giving the customers' battery proper attention. That is one of his strongest points—his customers would have the use of the car every day.

Mr. W. D. Vance: I want to say in justice to myself—I do not know whether Mr. Harvey referred to me.

Mr. W. L. Harvey: No, no.

Mr. W. D. Vance: My point was not to slight the work. My point was to evade the point that the gasoline people make to everybody that has a car in the shop to fix.

Mr. W. L. Harvey: You mean to make a flat price for a certain job?

Mr. W. D. Vance: No, charge a fair price for a fair job.

The Chairman: I think we understand the points that are made, that the salesman often tries to cover up the weak points, and when the customer finds them out he is dissatisfied; whereas, the long-sighted salesman gives a full account of what he is selling, and the result is satisfactory.

(To Be Continued.)

AMERICAN AUTOMOBILES IN SPAIN.

Consul-General Frank D. Hill of Barcelona, in writing on the automobile trade in Spain, states that he is in receipt of a report, made at his request by the agent of an American automobile manufacturer, in which the writer states:

An experience of several years' duration as manager of an important garage in Mexico, during which time he had ample opportunity to study American cars, has convinced him of their superiority over European cars in general.

In the first place the American car is carefully designed for travel over poor roads, many of those in Spain being in a deplorable condition. The American chassis is wonderfully strong, of great resistance, and high enough to permit passing over stones projecting eight or nine inches. As a rule European cars are built very low, the tendency being to increase the stability in this manner. The hang of the American car is superb, incomparably superior to that of the European, and in addition to numerous other advantages it possesses the most appreciable one of cheapness.

The cost of an American car is, in proportion, greatly inferior to that of any European make. For example, an average American car, 30/32 horsepower, equivalent to a French 16/20, with double phaeton tonneau, searchlight, lanterns, horn, cushions, hood, etc., well appointed in every respect, costs $2,800; while the French car 16/20 costs $3,184, leaving a difference of approximately $400 in favor of the American car. To this should be added the 20 per cent discount granted by American manufacturers, with the result that the net price of a completely equipped car is $2,240. Of course, freight charges and customs duties increase the prices shown, but these are practically the same for European as for American cars.

The American cars best adapted to conditions in Spain are first-class makes, ranging from 40 to 65 horsepower, and costing from $4,000 to $5,000; second class, small touring cars of 20 to 40 horsepower, ranging in price from $1,500 to $3,000; and runabouts for business men, doctors, brokers, agents, etc., at a cost of $850 to $1,000. These little cars present great advantages for Spain, being convenient, inexpensive, easy to run, and good hill climbers.

Excellent opportunities are offered to American makers of tires and accessories, owing to the good quality and cheapness of their products.

A set of American tires was tried in Barcelona and lasted exactly one year, in spite of continuous daily use on a car weighing 1,600 kilos (3,520 pounds). It is difficult to cite a similar example. Aside from their cheapness, accessories of American manufacture are to be recommended for their perfection and convenience, American makers progressing rapidly in this branch.

Drays and trucks for commercial use are almost unknown in Spain, and their introduction would undoubtedly be facilitated by familiarity with American systems, which are much cheaper than those imported from France or manufactured here.

Should American manufacturers care to exploit an excellent market, they ought to organize a permanent exposition in Barcelona. A stock of most improved models should be kept on hand, supplemented by tires and accessories of every description.

NEW AUTOMOBILE TRANSPORTATION COMPANY IN TOKYO.

Vice-Consul-General E. G. Babbitt of Yokohama forwards the following information regarding the organization of an automobile transportation company in Japan:

There was recently organized in Tokyo a transportation company for the purpose of transporting passengers and freight throughout that city. The capital of the company is 500,000 yens (yen = $0.498 gold), of which one-fourth has been paid in.

The intention was to start business with 20 motor cars, and a number of these have been ordered from France through a local business house. It is understood that a firm in Paris is supplying the cars, at an average cost of $3,000 gold. Five of these cars have recently arrived and undergone successful tests; two of them are for passengers, carrying six persons each, and the others light-delivery trucks of a loading capacity of 1½ tons.

Transportation of goods by automobile is a comparatively new undertaking for Tokyo. Several of these light-delivery trucks and vans have been used in Tokyo by private companies, but the fact that no orders were repeated is evidence that they were not considered economical or capable of competing with the cheap cooly labor that so largely takes the place of horse or mechanical transportation in Japan.

American manufacturers should not become possessed with the idea that they can send catalogues over here and receive orders and remittances by return mail; the Japanese want to see what they are buying. It appears that the present undertaking is rather a venture on the part of the French manufacturers and the local agent; that the success of the new transportation company is problematical; and that the cost of the machines, with 50 per cent ad valorem duty, with cost of operating and repairs, may take more than the profits of a business which is not assured them.

MEXICAN PRODUCER PLANTS.

The general adoption of producer gas in Mexican mining operations is well illustrated by the plant of the Capuzaya Mining Company, Parral, Mexico. Here a 300-horsepower Westinghouse gas engine generating unit was put in operation in February of the present year, operating on power gas generated from charcoal. This plant was installed to serve a large group of mining properties at Parral. This company has had a Westinghouse engine of the same size and design in operation for about a year. The National Iron & Steel Company, Mexico City, has also operated a producer gas engine plant for light and power service, and the Cia Industrial Jabonera, at Laguna, Mexico, installed a similar plant in 1906. Another important plant in Mexican territory may be mentioned, that of the Potosina Electric Company, San Luis Potosi, Mexico. This was one of the earliest and the largest installations in this part of the country, the first engines being installed in 1902. Another is that of the Empress Electricita Duraguena, Durango, Mexico, in whose plant is installed 320 horse power in suction producer.

CURRENT COMMENT

Competitive stoke-room firing reduced coal consumption 20% on some of the vessels of the U. S. fleet in its recent trip around the globe.

The largest hydro-electric plant in France is at the Tuileries works, ten miles from Bergerac, which has been designed to develop 23,000 horsepower.

Vanadium bronze, on account of its non-magnetic properties, is to be used in the construction of the new magnetic survey yacht for the Carnegie Institute of Washington.

An alloy cannot be made with aluminum and sodium, as the sodium remains at the top and the aluminum at the bottom of a mixture. Nor will thallium, lead and bismuth mix.

Coal in Japan is obtained chiefly from Kiushiu, the southernmost of the islands, and from Hokkaido, the most northern. The former produces two-thirds of the entire output of Japan.

Heroult electric furnaces are being built for the South Chicago works of the Illinois Steel Company and the Worcester plant of the American Steel and Wire Company, both being 15-ton furnaces. These are to refine the steel by eliminating phosphorus, sulphur and slag.

"Krytol," for use in electric furnaces, is a patented compound of graphite, coke and carborundum, put up in uniformly sized grains. Resistance is increased by increasing the proportion of coke and carborundum. It is used either loose or in glass tubes for the production of steady low temperatures.

Electric welding is being largely used in the manufacture of chains, the electric machine being able to weld from four to five hundred links per hour for small chains, formerly done at the rate of twenty per hour by hand. Iron to be welded electrically must be free from phosphorus and silica and contain manganese.

Electrical Sterilization of water is under experiment for the water supply of Paris. Ozonized air is forced into sterilizing columns by means of an electric pump. The process removes practically all the colon bacilli from turbid river water, previously filtered through sand filters. It requires 10,600 kw.-hr. per million gallons of filtered water and 12,490 kw.-hr. per million gallons of turbid water.

The Stassano electric furnace has replaced the crucible in the manufacture of steel at the Bonner Fraserfabrik, Germany. There are two one-ton furnaces in the plant, each of 250-horsepower, one being kept in reserve. They employ three-phase current at 110 volts 50 cycles. The treatment of a one-ton charge takes five hours, including 1½ hours for de-phosphorizing and de-sulphurizing. The current consumption is 900 kw.-hrs. per ton.

An anti-smoke campaign has been instituted by the Pennsylvania Railroad among its engineers and firemen, in a general order issued recently to all lines east of Pittsburg, to the effect that "smoke means waste and must be avoided." Five assistant road foremen are instructing firemen how to reduce the quantity of smoke. The coal bill of this road is $10,000,000 annually, and it is believed that $100,000 could be saved every year with more economical handling of coal.

A new source for rubber has been found in a plant in Portuguese West Africa, the roots of which contain rubber-yielding latex. The roots are chopped into pieces and are then subjected to pressure. From this liquid the rubber is prepared by heating or exposure to the air. The plant is locally known as "bitinga." Experiments are being made to see if it is likely to pay for cultivation.

Electric pumping and hoisting is to be installed at the Old Dominion copper mines at Globe, Ariz. The power plant will be placed in the smelter power house and have a capacity of 2,000 kilowatts.

Electric automobiles in the Glidden tour for 1909 are planned as the result of a 2140-mile trip between Lincoln, Nebraska, and New York City recently made by O. P. Fritchlie in a Fritchlie machine. The machine averaged ninety miles a day over bad roads.

High tension bronzes, such as manganese bronze, on account of their tensile strength and elongation, which approximates that of steel castings, are excellent for high pressure marine boilers. These qualities continue even at the high temperature here attained. For valve fittings there is no trouble with liquidation, as in the case of gun metal castings.

The photo-electric cell is a new form of dry battery, theoretically interesting but of little practical value at present. Dr. J. A. Fleming describes such a cell in a recent paper in the Philosophical Magazine. It consists essentially of a glass tube from which the air has been exhausted and having a strip of platinum at one end and a plate of fluid amalgam of sodium and potassium at the other. When a powerful light is concentrated on the latter an electric current flows from the platinum to the amalgam through the vacuum tube. This current is at a potential of one-half volt and amounts to about five micro-amperes. The light frees negative ions from the alloy which liberate their electric charge upon striking the platinum. This produces a positive electric current in an outside circuit. This is probably the basis of certain sensational articles in the daily press.

THE JOHN W. MACKAY JUNIOR FELLOWSHIPS

In July, 1906, Mr. Clarence W. Mackay, jointly with his mother, Mrs. John W. Mackay, gave to the University of California one hundred thousand dollars, for the endowment of the John W. Mackay Junior Professorship of Electriral Engineering, with the proviso that such part of the income as the Regents of the University might determine, or the whole, was to be used for the salary of the incumbent of the chair, and that the residue of the income was to be devoted to the furtherance of research work in electrical engineering in the University.

In accordance with the terms of this endowment the University of California has established two *John W. Mackay Junior Fellowships in Electrical Engineering*, of an annual value of six hundred dollars each. The tuition charges of the University are nominal. These fellowships are open to all properly qualified university graduates.

The object of the fellowships is not to facilitate ordinary engineering or scientific study, but to enable students who have completed a college course to do research work in electrical engineering, with a view to aiding the advance of the application of electricity to scientific and industrial purposes.

The place of residence of those holding the fellowships is to be at the University of California. Experimental or other work, however, may be carried on outside the laboratories of the University.

Opportunities for study and investigation in Electrical Engineering at the University of California are extensive, and the laboratories are well equipped for investigation and research work. The appointment to each fellowship shall be for one year, which appointment may, however, be renewed, at the discretion of the Graduate Council of the University.

Applications for these fellowships should be filed with the Recorder of the Faculties, Berkeley, Cal., as early as March 15th, if possible.

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Pulverized Coal

For years "slimes" caused as much trouble in cyaniding gold ore as did "fines" in the burning of coal. The cyaniding problem was finally solved by crushing the ore in a tube mill until it was all converted into "slimes." An analagous solution has proved successful in the problem of burning fine coal by first pulverizing it so as to properly prepare it for combustion. Much of the Portland cement in this country is burned with pulverized coal, and it is also fast finding its way into other industrial and metallurgical establishments.

Powdered coal has several advantages, including complete combustion, minimum ash and high temperature. The coal is first crushed, then dried and finally pulverized, so as to pass a hundred mesh screen. The firing is accomplished much as with crude oil, the object being to get a good mixture of coal and air. The latter is furnished under pressure, and the coal dust is supplied to an injector by a screw conveyor. It is interesting to see how the same treatment has overcome the difficulty in two instances apparently so different. In competition with oil or natural gas, it is not feasible, but where there is abundance of low grade coal, this is one of the best methods of consuming it.

Limitations of Low Head Water Power

There is much talk of the possibilities of the development of electric power from the extremely low heads available in large rivers. It is argued that although many of the high head water powers have already been utilized, there is yet abundant power available in other streams. Investigation shows that there are two considerations that limit this Utopian dream.

With a head of twenty feet, or less, the speed of a turbine is so low that the generator to which it is connected must be so large and have so many poles, that it becomes not only mechanically undesirable, but also economically impracticable. Its cost is excessive. Indirect drive by gear, rope or belt introduce complications which so increase the cost that the development of low head water power is profitable only where electricity commands a high price.

The second reason is one of safety. Most streams are subject to floods, and as a matter of precaution a power plant should be placed well above high water mark, which greatly reduces its effective head. This is exemplified by the plant on the Willamette River, in Oregon, whose output is materially curtailed during periods of high water.

When a low head is to be utilized a reaction turbine is employed, because its speed is approximately that of the water flowing through it, while the speed of an impulse wheel is but one-half that of the water. It is for this reason that the impulse turbine only is advisable for a very high head where the reaction type would give too high a head.

One of the most interesting low head installations

in the world is that nearing completion at McCall's Ferry on the Susquehanna River in Pennsylvania. Here one hundred and thirty-five thousand horsepower is to be generated by ten turbines under a head of fifty-three feet at ninety-four revolutions per minute. Each of the generators weighs almost three hundred million pounds. These same generators would develop three times as much power, if used under the head available at Niagara Falls, and ten times as much if under that at Centerville, California. If they were used at the extremely low head under discussion, they would develop less than half the horsepower. This plant is in the midst of a region of cheap fuel, and is to furnish electricity in competition with that developed by steam power, and therefore stands as an example of what can be accomplished at a moderately low head, and also shows how unwieldly a generator might become under a very low head. Under present conditions we can hope for but little power from streams running through a country of low relief.

BOOKS RECEIVED.

"General Lectures on Electrical Engineering," by Charles P. Steinmetz, A. M., Ph. D., edited by J. L. R. Hayden, 284 pages, 6x9, cloth, gilt top, hand tinted portrait, 48 diagrams. Price $2.00 postpaid. Robson & Adee, Schenectady, N. Y., and Technical Book Shop, San Francisco.

This attractive volume brings into compact form a number of lectures, general in character, describing some perplexing problems in electrical engineering. By eliminating the calculus from his discussions the author has removed the usual stumbling block to a clear comprehension of this subject by those not expert in "mathematical shorthand." This book is not an elementary treatise. It presupposes a knowledge of all ordinary electrical terms and a familiarity with electrical apparatus. Each lecture is a unit in itself, yet all are connected by a logical sequence. After an introductory review of the requirements of the various applications of electric power and a discussion of the kind of electric current best fitted therefor the author first takes up the distribution of light and power by direct and alternating current, together with load factor and the cost. He next treats the subject of long-distance transmission, frequencies, voltages and losses, including transformer connections. Higher harmonics of the generator wave and high frequency oscillations and surges are each the subject of a lecture. Under generation a comparison of prime movers is made and the different needs of each class of service broadly discussed. Succeeding lectures deal with the hunting of synchronous machines, regulation and control, and lightning protection. About fifty pages are devoted to three lectures on the electric railway, its train and motor characteristics, particularly those of the alternating current railway motor. A lecture is devoted to electrochemistry, one to incandescent lamps, and one to arc lighting. The volume is concluded with an appendix on light and illumination and one on lightning and lightning protection. Diagrams have been introduced frequently to supplement the text. In the course of the preface it is stated that this book "comprises a discussion of the different methods of application of electric energy, the means and apparatus available, the different methods of carrying out the purpose, and the relative advantages and disadvantages of the different methods and apparatus which determine their choice." Coming from such an authority and presented in such an admirable form, this is a volume that is worthy of a place in the library of every electrical engineer. Its chief defect is the absence of an index, which would greatly enhance its utility. A cursory examination indicates several typographical errors which will undoubtedly be corrected in future editions. With so much to praise and so little to condemn, the book is a most valuable contribution to the classics of electrical engineering.

PERSONAL.

George Curtis of the Waterman, Davis & Curtis Co., electrical contractors of Sacramento, was in San Francisco this week with his wife.

J. W. Perry, of the New York office of the H. W. Johns-Manville Company, is in San Francisco in the course of his annual trip to the Pacific Coast.

Thomas I. Stacey, treasurer of the Electric Appliance Company of Chicago, accompanied by his wife, left San Francisco this week for Los Angeles.

H. M. Lauritzen, recently with the sales department of the New York office of the Holophone Company, has joined the San Francisco force of the same company.

G. A. Scoville, Pacific manager for the Dean Electric Company, of Elyria, Ohio, has returned to San Francisco after a business trip of about a week in the South.

J. E. Way, of the R. Thomas & Sons Company, East Liverpool, Ohio, who has been in the Northwest, has been compelled to abandon the balance of his Coast trip and return to the East owing to the sudden death of his father-in-law. Mr. Way is planning to return to the Coast at an early date and complete his trip, which will include San Francisco and Los Angeles.

TRADE CATALOGUES.

The General Electric Company in Bulletin No. 4646 presents interesting data relative to the quality of light produced by tungsten lamps, simplicity of construction, adaptability to both alternating and direct current circuits, and various other data relative to life and economy.

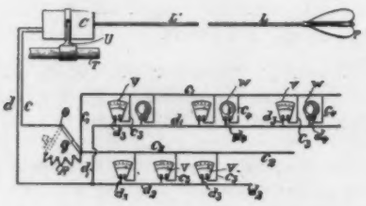
In Bulletin No. 4649, just issued by the General Electric Company, the relative advantages and disadvantages of "Independent Drive" and 'Group Drive" of machine tools are demonstrated. While the title of the bulletin refers to Railroad Shops, the data are applicable to machine shops in general.

A list of engine type direct current generators sold by the Crocker-Wheeler Company, Ampere, N. J., is given in their Bulletin No. 110. This list, covering fifteen pages, gives the names and addresses of companies and individuals using these generators. Industrial plants, street railways, railroad and other machine shops, office buildings, stores, schools and residences are included in the list. In several items no address is given, these being United States battleships, several of which are equipped with Crocker-Wheeler generators.

The ease with which the Tungsten lamp is adapted to street lighting is shown in Bulletin No. 4647, just issued by the General Electric Company. There is no lamp of small or moderately large units of light that is as economical as the Tungsten series lamp, and it is, therefore, ideal for suburban and residential street lighting. Inasmuch as the high current lamps are just as efficient as those for low current, the Tungsten series lamp can be used in conjunction with series arc lamps without the necessity of having two circuits. The bulletin contains curves showing candle-power distribution of this lamp under different conditions, illustrations of constant current transformers and series lamp socket used in connection with the lamp, and several diagrams showing the advantages to be derived from the use of the Tungsten lamp for series street lighting.

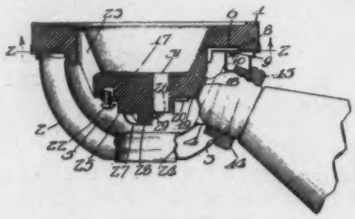
PATENTS

912,291. Electric Log. John H. Cuntz, Hoboken, N. J. A ship's log including a casing adapted to be supported on or from a ship's rail, electric generating means in said casing, mechanism connected with said generating means, a log line



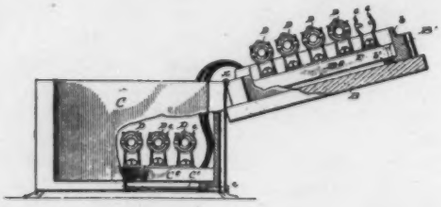
attached to said mechanism and extending to a propeller, a propeller, speed indicators on the ship separate from said casing, and electrical connections from said indicators to the mechanism in said case.

912,529. Plural Lamp Socket. Reuben B. Benjamin, Chicago, Ill., assignor to Benjamin Electric Manufacturing Company, Chicago, Ill. In a cluster or plural lamp socket, a suitable basic or supporting part, lamp supporting means detachably connected with said basic or supporting part, a



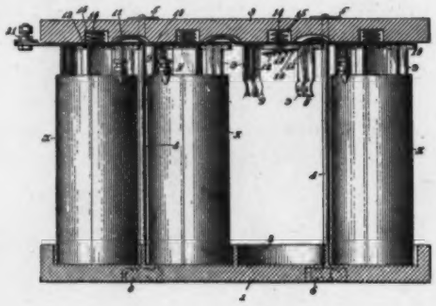
circular metallic casing having lamp openings carried by said lamp supporting means, registering center contacts suitably inclosed by said casing, and binding posts suitably disposed within said casing and adapted to be disclosed by the detachment of said casing and lamp supporting means.

912,871. Controller for Electric Motors. Robert L. Munson, Seattle, Wash. A controller box having a hinged cover and provided with parallel series of spring socket clips, one



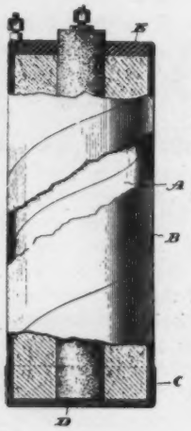
series of clips being carried by said cover, and detachable resistance coils mounted in said socket clips parallel to the hinged cover and arranged to be exposed by turning back the cover.

912,705. Battery Holder. Charles T. Mason, Sumter, S. C. A battery holder for electric cells, comprising frame or support, and a series of cell connectors carried thereby, each of said connectors including an annular conductor plate having



a series of cell engaging spring fingers projecting therefrom, and a resilient integrally formed tongue the outer end of which extends into and lies within the open center of the next successive conductor plate.

912,946. Dry Battery Cell. George N. Eastman, Riverside, Cal. The method of making dry batteries which consists in winding a sheet metal electrode into tubular form, incasing



said electrode with a self-adhering fibrous material, closing one end of said tube, introducing the excitant filling and electrode and sealing the tube.

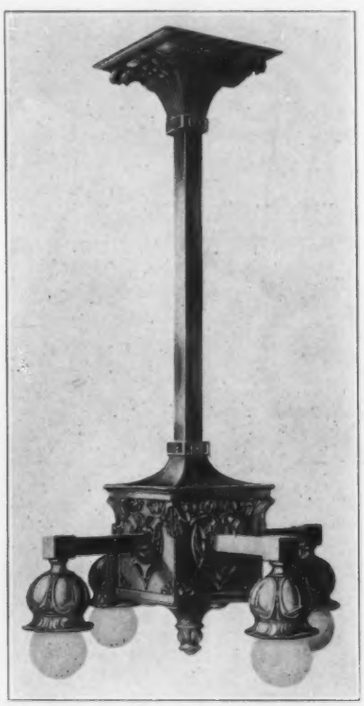
912,554. Artificial Fuel. Ira Foreman and John L. Thornton, Los Angeles, Cal., assignors to Pressed Wood Co., Los Angeles, Cal. The herein described method of manufacturing

artificial fuel which consists in providing a fibre core under tension and packing around and bonding to such fibre core planing mill shavings under pressure of 250 pounds to the square inch.

INDUSTRIAL

WESTINGHOUSE-NERNST CHANDELIERS.

Since the new Westinghouse-Nernst chandeliers were put on the market several attractive variations of the original designs have been added to the list. One of the most pleasing is the square art nouveau cast chandelier shown in the accompanying illustration. It is slightly more massive than the other designs and its ornamental treatment is somewhat



Westinghouse-Nernst Chandeliers.

more pronounced, without, however, sacrificing the simplicity characteristic of all these chandeliers. This design is made with either two or four arms and equipped with 66, 88, 110 or 132 watt lamps, either 110 or 220 volts, as desired. The four arm 132 watt chandelier has an illuminating value equivalent to 28 16-candlepower carbon filament lamps.

HARVARD ELECTRIC COMPANY'S GROWTH.

The Harvard Electric Company, 66 West Van Buren street, Chicago, and 136 Liberty street, New York, manufacturers of electrical necessities, have begun the year of 1909 with numerous evidences of growth. Its president, Fredric Greer, is one of those who predict great things for the coming era of prosperity.

This company has recently greatly increased its space and more than doubled the capacity of its plant.

This company manufactures Harvard patent channel steel brackets, beveled edge wire joints, sectional switch boxes, conduit boxes, telephone fuses, lightning arresters, fuse wire, fuse strip, open fuse links, magnet winders, cable hangers, portable lamp guards, test connectors, etc., etc.

The advance 1909 No. 17 bulletin illustrating a part of the products of this company has just been issued and distributed to the trade. Copy of this bulletin will be forwarded to any one interested, upon request.

THE NORTHERN ELECTRIC ROCK DRILL.

Considerable interest is being manifested in the mining field by the introduction of a new type of electrically driven rock drill by the Northern Electrical Manufacturing Company, of Madison, Wis., recently consolidated with the Fort Wayne Electric Works, which is a radical departure from anything heretofore offered in place of its predecessor, the air drill.

The accompanying illustration is a photograph taken of this drill while in operation, and is notable for the absence of vibration while running.

It has been demonstrated a number of times that it is practically impossible to transmit the energy from an electric motor to a piston type of drill, due to the excessive vibration and jar on the apparatus as a whole. This drill is rotary in

Northern Electric Rock Drill in Quarry.

its action and embodies one or two hammers (as the case may require), mounted in a rotating body where full advantage is taken of the storage of energy possible in a flywheel. This is in very marked contrast to any form of drill where the blow is imparted to the rock through the medium of a reciprocating piston. The accompanying figure shows the hammer mechanism in place and is self-explanatory of the general design of the apparatus.

As the helve revolves the hammer is thrown outward into striking position by centrifugal force. Reaching the projecting head of the drill chuck, it delivers to it in the form of a blow the energy stored up in the revolving helve. The hammer,

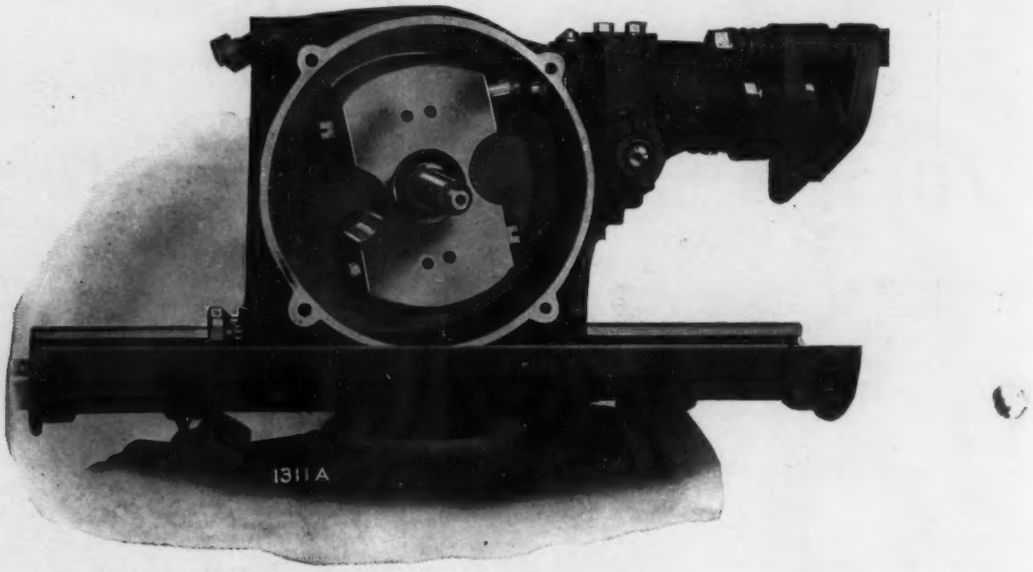
after delivering the blow, rebounds into the chamber in the helve, where it is cushioned so completely by the air which it traps that no vibration is imparted to the drill itself.

It is noticeable in the illustration that no weights at all are used to absorb vibration, as is common in air and piston type of drills.

The chuck and drill steel are held into the drill body by means of a laminated steel combination buffer head and clamp, which both locks the steel in place and absorbs the shock when the drill is not cutting. The object of this buffer head is to permit operating the drill at full speed when the drill is not seated on the rock.

By the use of the hollow drill steel it is possible to drill deep holes in any direction in the softest rock or ores of high specific gravity, which under actual drilling break into small fragments instead of pulverizing. In working in various hard rocks and shallow holes it is not necessary to use water with the drill, although in many instances it is highly advisable to use the water system to kill the dust, which it is impossible to do with a steam or air drill using solid drill.

The drill steel is not reciprocating, and therefore cannot be jammed into a fissure or cleavage crack. To rotate the drill steel a simple mechanism has been devised which gives the drill a positive turning action. Much interest is centering around this new type of drill and its future will be watched with high expectations by those who believe that all things are possible through the medium of electrical applications.



Mechanism of Northern Electric Rock Drill.

SODIUM FOR DRYING TRANSFORMER OILS.

Recent experience in connection with the drying of transformer oils indicates that by the use of metallic sodium moisture may be completely removed from oils which are to be used for insulating purposes. This means, of course, that the insulating qualities of the oil will be raised in a very marked degree.

The method of using sodium for drying hydro-carbon oils is one that is familiar to every chemist who has ever measured the di-electric constants of these oils where the sodium is usually added in the final operation to remove the very last traces of moisture. In the fear that the caustic formed by the reaction of the moisture on the sodium might be left as a liquid or a solid in the hydro carbon, the chemist has usually thought it necessary to distill off from the sodium. In working on a very large scale this fear has been found to be groundless, and it is absolutely unnecessary to distill the oil.

The oil on the granulated sodium is poured off and a good transformer oil poured over the metal. To the oil which is to be treated, and which is put into an open tank or barrel, the sodium is added at first very carefully, about one ounce to the barrel. If much hydrogen is evolved this will be conclusive proof that there is much water in the oil, and the balance of the sodium should be added carefully and in small amounts. The amount which is to be added depends upon the oil, but as a rule one pound to the barrel is usually much more than is required. The oil is then stirred up three or four times a day for a minute at a time. After several days the oil may be removed and tested, but the longer it remains over the sodium the better the oil becomes.

Another method used is to put the sodium in the form of sticks in a cylinder of iron wire of about 28 mesh and hang the cylinder in the oil.

One company has taken oils which broke down at 3,000 volts and by letting them stand over the sodium for two days have brought their breaking points up to 20,000 volts or higher.

The Roessler & Hasslacher Chemical Company of New York are selling agents for sodium.

U. S. GEOLOGICAL SURVEY TESTING PLANT.

The long series of producer gas tests on various grades of bituminous coal conducted by the United States Geological Survey at the St. Louis Exposition have been productive of such fruitful results that the testing work has been perpetuated, and the Government has secured for this purpose a 140-horsepower Westinghouse 3-cylinder vertical single acting gas engine. This engine is of the same type as that installed at St. Louis, upon which all of the producer gas tests were made. An important schedule of experimental work has been laid out by the Government engineers, and tests will be run on all classes of bituminous coals, lignites, peat, etc.

TRADE NOTE.

R. P. Chevalier, 930 Lincoln avenue, Alameda, Cal., has recently installed complete laboratory equipment for fuel analysis, both oil and coal, and is equipped to handle every detail of testing boilers and engines. This apparatus includes every device from scales to fuel calorimeter, making it one of the most complete equipments for such tests on the Coast

NEWS NOTES

FINANCIAL.

OAKLAND, CAL.—The Southern Pacific Company has made public the terms of its contracts for equipment for an electrical power station at Fruitvale, on the tidal canal, and for motor cars for the electric propulsion of local trains when steam power is discarded. The contracts called for an expenditure of $748,960 and were placed with Eastern firms late in the year 1907. The General Electric Company of Schenectady, N. Y., secured the contract for the rolling stock, calling for 44 multiple unit, four motor cars, the contract price being $374,960. The stationary equipment in the power house, consisting of two 5,000 kilowatt turbo-generators capable of supplying current for a widely distributed trackage, will be supplied by the Westinghouse Company, of East Pittsburg, at a contract price of $190,000. Steam for the operation of the turbo-generators will be supplied from a battery of twelve 645-horsepower water-tube boilers. The boilers will be installed by the Parker Boiler Company, of Philadelphia, at a cost of $137,000. The condensing outfit will be supplied by the Henry R. Worthington Company of New York at a cost of $47,000. Work on the power house has been begun and is being actively rushed to completion, after which work will begin on the overhead system for the electric trains.

INCORPORATIONS.

SAN FRANCISCO, CAL.—The Specializing Hardware & Electrical Company has been formed here with a capital stock of $25,000 by S. L. Bigelow, J. H. Kahn and H. C. Thaxter.

LOS ANGELES, CAL.—The C. C. Harris Oil Company has been formed here with a capital stock of $300,000 by John D. Bicknell, J. C. F. Hull, H. G. Gates, E. E. Gates and C. C. Harris.

VISALIA, CAL.—The Monache Water Company has been incorporated here with a capital stock of $14,000, the principal place of business being Porterville. The incorporators are J. H. Williams, of San Diego, W. E. Sprout and A. J. Newbury, of Porterville.

TRANSMISSION.

TONOPAH, NEV.—The Nevada California Power Company has begun work on the construction of the new power line to Manhattan and Round Mountain.

CANANEA, MEXICO—The Pinos Altus Mines Company is at work installing one of the most complete electrical equipments used in any of the mines of this country.

CHICO, CAL.—An application has been made by Frank C. Wilson, representing the Sierra Electric Power Company, for a franchise for the transmission of power in this city.

PASADENA, CAL.—An ordinance has been passed here calling for the issuance of bonds to the amount of $150,000 for electric generators and other municipal improvements.

PRESCOTT, ARIZ.—Hon. I. T. Stoddard has about completed plans for installing electrical machinery in the mines near Stoddard, arranging for power from the Arizona Power Company's plant on Fossil Creek.

PHOENIX, ARIZ.—President Charles S. Smith, of the Old Dominion Copper Company at Globe, Ariz., has about completed plans for the installation of a 2,000-kilowatt plant in the smelter power house at Globe.

SAN JACINTO, CAL.—Mr. Whittier, owner of the Hemet dam, in the San Jacinto Mountains, announces that the expenditure of a million dollars is contemplated in the near future on the erection of an electrical power plant which is to be installed below the dam, which is now being raised 25 feet higher.

MESA, ARIZ.—Superintendent Hector Gillis, at Granite Reef, is rushing the work of connecting the Consolidated canal with the headgates of the big dam at Arizona heading, where a power house is soon to be erected.

ILLUMINATION.

YACOLT, WASH.—J. Coulter has been given a contract to construct a light and power plant for Yacolt.

SAN DIEGO, CAL.—A contract has been let to Shaffer & Moses to lay underground light mains and install fixtures for the ornamental lignt system on D street.

SIERRA MADRE, CAL.—Bonds have been issued in this city for $30,000 for erecting a gas plant with a capacity to serve 6,000 families. Work is to begin within three months.

SAN FRANCISCO, CAL.—Sealed bids will be received by the Board of Public Works till March 8th, 1909, for electrical wiring and apparatus for the O'Farrell street truck house No. 1.

COLUSA, CAL.—The Pacific Gas & Electric Company is soon to begin a number of improvements here, the most important of which is the installation of a 20,000 cubic foot gas holder tank.

LOS ANGELES, CAL.—Specifications for new machinery needed by the municipal electric light plant, amounting to between $35,000 and $40,000, have been presented to the City Council.

HUNTINGTON BEACH, CAL.—Lee Ledanyi has purchased the controlling interest in the local gas plant from F. M. Burbank and it is expected that extensions and improvements will soon be made.

SAN BERNARDINO, CAL.—It is understood that C. S. Chestnut, of Redlands, the recent purchaser of the Colton gas plant, will build a large central gas plant in Colton for supplying that and other towns with gas.

AZTEC, N. M.—The Eden Canal, Land & Power Company has begun work on the construction of its new electric light plant which is to be located on two acres of land acquired a few weeks ago from L. Current.

PASADENA, CAL.—Bids will be received till March 23, 1909, for furnishing this city with materials and equipment for a municipal light plant. The desired articles are one surface condenser and equipment, one 750-800-kilowatt, 3-phase, 60-cycle, 2,300-volt engine-type alternating current generator, together with a 50-kilowatt 125-volt belted exciter, and one additional exciter, 1 vertical cross-compound condensing engine, one 750-800-kilowatt turbo-generator unit.

TRANSPORTATION.

LEWISTON, IDAHO.—Nearly $80,000 has already been raised for the construction of the electric railway at Lewiston.

SAN DIEGO, CAL.—A franchise for a period of twenty-five years has been granted the Point Lomo Railroad Company.

LOOMIS, WASH.—Work is to be commenced at once on an electric railway from Loomis to Nighthawk. I. Inman is in charge.

EUGENE, OREGON.—The Portland, Eugene & Eastern Railway expects to complete the electric road between Eugene and Springfield this year.

SPOKANE, WASH.—The Washington Water Power Co. is starting the construction of a new hydro-electric power house to furnish power to the Medical Lake and Cheney lines.

FRESNO, CAL.—F. S. Granger announces that rights of way have been secured for the Fresno-Hanford Railway from Hanford to the Calwa winery and that everything is in readiness for work to begin.

SANTA, ANA, CAL.—The Pacific Electric Company has not decided whether it will build its line direct from Los Angeles or run it from Talbert to Garden Grove and there connect with the line already in operation.

VALLEJO, CAL.—Attorney York, of Napa, acting for the Vallejo, Benecia & Napa Valley Electric Railway, has asked the trustees for a new route from this city in order that the company may escape the grade on Sonoma street.

PORTLAND, ORE.—Permission has been granted the Portland Railway, Light & Power Company to lay its tracks for an extension through Fairview to connect with the O. R. & N., pending the passage of a 30-year franchise by the City Council.

NORTHBEND, ORE.—Seymore H. Bell, representing the Coos Bay Electric Railway Company, announces that work on the construction of the electric road between Marshfield and this point will begin as soon as the thirty-year franchise is granted.

SACRAMENTO, CAL.—The Central Traction Company has applied for an electric railway franchise in this city. When this is granted construction work will begin immediately. The building of this road will complete the company's line from Stockton to this city, and a saving of twenty-five minutes will be made to Eighth and L streets. It is understood that an agreement has been reached under which the Central Traction, the Vallejo Northern, and the Northern Electric companies will build a union depot for passenger traffic near Eighth and I streets. Within a few months the Northern Electric Company will have completed rail connection with the river, thus affording development of its freight business.

OIL.

GOLDFIELD, NEV.—Oil in considerable quantities has been struck in this vicinity at a depth of 825 feet.

LOS ANGELES, CAL.—A protest has been raised by the Mayor and citizens of Santa Barbara against the Union Oil Company running its pipe lines into the Pacific Ocean to serve ships and trade generally. The complaint is that the city's reputation as a beach resort will be ruined.

FRESNO, CAL.—A deal has been closed during the past week whereby the ownership of 120 acres of proven land in the heart of the oil district has been acquired by a number of Southern California capitalists for a price that is not known. It is reported that a corporation is to be formed and active development will be commenced.

BAKERSFIELD, CAL.—At the annual meeting of the Associated Oil Company, held last week, the following officers were chosen: President, J. A. Chanslor, San Francisco; W. S. Porter, first vice president and general manager, San Francisco; W. F. Chandler, second vice president, Selma; secretary, O. Scribner, San Francisco, and treasurer, W. A. Sloane, San Francisco.

BAKERSFIELD, CAL.—A suit by James H. Martin against the Sunset Rex Oil Company, Mark B. Smith, Mary H. Smith, Harold Smith, John Doe and Richard Roe, is now in the Supreme Court to decide whether "non-assessable" oil stock is assessable. The plaintiff claims that he bought $700 worth of stock in the company, with the understanding that it could not be assessed, but that thereafter the board of directors levied an assessment of 10 cents per share on the company's stock and that his stock is now about to be sold.

LOS ANGELES, CAL.—Because of the disordered traffic resulting from the floods and the increase of shipments due to the heavy demand, a car famine has resulted in the Kern county oil fields, reports A. G. Nichols, field manager for a number of companies. Water has also become quite scarce in a number of localities, several companies securing water from the wells about Santa Maria Springs. The Temblor Company has opened up a new field north of McKittrick and the Oneonto Company has begun big developments.

WATER.

COALINGA, CAL.—Rubenstein, Cospers & Kauntze, of Hanford, have been granted a franchise to lay a water system in this city.

SANTA CLARA, CAL.—The bids of the United States Pipe Company for forty-four and one-half tons of pipe at $34.70 and for one ton of fittings at $65 have been accepted.

PETALUMA, CAL.—Sealed bids will be received till May 3d, 1909, by the city clerk for furnishing and installing the pumping machinery for a salt water high pressure fire system in this city.

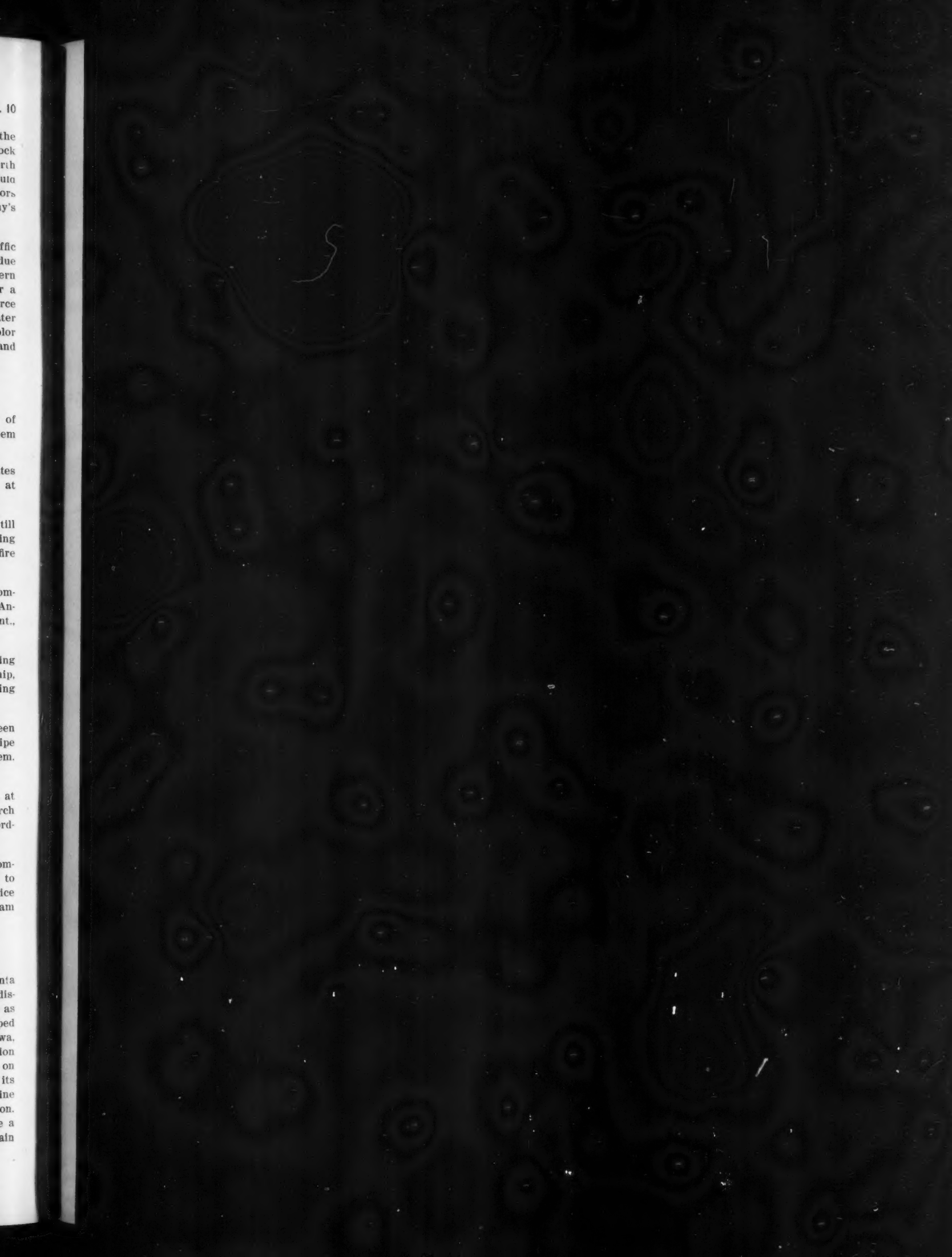
GLENDORA, CAL.—The Glendora Mutual Water Company has sold $35,000 in bonds to Adams & Co., of Los Angeles, at very near par value, to bear interest at 6 per cent., on long terms of payment.

EUREKA, CAL.—The Eureka Water Company, following the recent steps taken toward securing municipal ownership, has announced that $100,000 will be spent during the coming year in making improvements to its system.

SAN FRANCISCO, CAL.—Formal approval has now been given to the specifications for the 45,000 tons of cast iron pipe required for the proposed auxiliary fire protection system. Bids have been called for to be opened March 10th.

SAN FRANCISCO, CAL.—Sealed bids will be received at the office of the Board of Public Works of this city till March 10th, 1909, for furnishing and delivering cast iron pipe, according to the specifications prepared by the city engineer.

GRIDLEY, CAL.—The Nevada Machinery & Supply Company, of San Francisco, has been awarded the contract to furnish a pumping plant for the city water works, the price being $7,820. The plant will include a steam boiler and steam pumps and also electric motor and centrifugal pump.

TELEPHONE AND TELEGRAPH.

SAN FRANCISCO, CAL.—The Atchison, Topeka & Santa Fe will begin installing the necessary equipment for dispatching by telephone on 1,124 miles of its road as soon as the material can be supplied. The territory to be equipped includes the line from Chicago to Emporia, Kans., via. Ottawa, Kans.; from Bakersfield to Oakland on the valley division of the coast lines, and from Somerville, Tex., to Beaumont, on the gulf lines. The company has already 226 miles of its road operated by telephone dispatching and the entire line from Kansas City to Newton will be ready for service soon. This, with the proposed addition of 1,124 miles, will make a total of 1,350 miles of road that will have telephone train wires.